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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 17741 and 18064.

17562 (AE-267) BURN-UP DETERMINATION BY HIGH RESOLUTION GAMMA SPECTROMETRY: AXIAL AND DIAMETRAL SCANNING EXPERIMENTS. Forsyth, R. S.; Blackadder, W. H.; Ronqvist, N. (Aktiebolaget Atomenergi, Stockholm (Sweden)). Feb. 1967. 19p. Dep. mn.

In the gamma spectrometric determination of burn-up the use of a single fission product as a monitor of the specimen fission rate is subject to errors caused by activity saturation or, in certain cases, fission product migration. Results are presented of experiments in which all the resolvable gamma peaks in the fission product spectrum have been used to calculate the fission rate; these results form a pattern which reflect errors in the literature values of the gamma branching ratios, fission yields etc., and also represent a series of empirical correction factors. Axial and diametral scanning experiments on a long-irradiated low-enrichment fuel element are also described and demonstrate that it is possible to differentiate between fissions in U-235 and in Pu-239, respectively, by means of the ratios of the Ru-106 activity to the activities of the other fission products. (auth)

17563 (ARL-67-0002) DEVELOPMENT AND APPLICATION OF METHODS FOR ANALYSES OF RESEARCH MATERIALS. Henry, W. M.; Heffelfinger, R. E. (Battelle Memorial Inst., Columbus, Ohio). Dec. 1966. Contract AF33(657)-8108. 67p.

Results are reported for studies on: stoichiometric measurements, trace element analyses, and emissivity measurements on zirconia; analysis of high-purity materials, such as Cr, Fe, Al, and ThO_2; analysis of alloys and mixed oxides including CuPt, Co-Pd, and ZrO_2-HfO_2; bromine diffusion in NaCl single and bicrystals; determination of Ni in the FeO phase of a Fe-Ni-O system; and miscellaneous studies on analysis and electron microscope examinations on various materials. Equipment and techniques used are also described. (P.C.H.)

17564 (BNWL-396) PLUTONIUM ABSTRACTS. Volume 7, Number 1. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 31, 1967. Contract AT(45-1)-1830. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

References (88) are given to journals, reports, and conference proceedings published from 1959 through January 1967. The subjects covered include: biology and medicine; chemistry; health and safety; metallurgy and ceramics; physics; reactor technology; and miscellaneous. Abstracts are given for each reference where possible. (P.C.H.)

17565 (KFK-499) BESTIMMUNG DER FREIEN SAEURE IN SALPETERSAUREN KONZENTRIERTEN PLUTONIUM-IV-LOESUNGEN. (Determination of the Free Acid in Concentrated Nitric Acid Solutions of Plutonium(IV)). Baehr, W.; Thiele, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Aug. 1966. 8p. Dep. mn.

A method for determining of the free acids in Pu(IV) solutions up to concentrations of 1 M is described. The hydrolysis of Pu^{4+} is avoided by use of iodic acid. (tr-auth)

17566 (USNRDL-TR-67-11) A RAPID ION EXCHANGE METHOD FOR THE CONCENTRATION OF COBALT FROM SEAWATER. Lal, M. G.; Goya, H. A. (Naval Radiological Defense Lab., San Francisco, Calif.). Nov. 29, 1966. Contract AT(49-5)-2084. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A chelating ion-exchange method was devised for the quantitative extraction of cobalt from relatively large volumes of seawater. This method was needed for the study of seawater corrosion of cobalt-based SNAP-fuel encapsulant alloys. The method consists of passing the acidified seawater sample through a column of Chelex-100 ion-exchange resin, then eluting the cobalt from the column with 4N hydrochloric acid. (auth)

17567 (WCAP-3690-2) DEVELOPMENT OF A BORON CONCENTRATION METER. Quarterly Progress Report for the Period Ending January 31, 1967. (Westinghouse Electric Corp., Pittsburgh, Pa. Atomic Power Div.). Feb. 1967. Contract AT(30-1)-3690. 56p. (EURAEC-1778). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Laboratory and conceptual design studies were carried out in order to establish the probable operating characteristics of an in-line boron concentration meter for determining boron concentrations in the coolant of a closed cycle, water moderated and cooled power reactor. It was concluded that a mannitol-addition meter can be constructed that will measure boron concentration within a delay time of approximately 1 min. The accuracy of such a meter will be at least ±0.6% with manual or digital readout and at least ±1% with a null-bridge recorder. The use of a low temperature boron concentration meter reduces the quantity of mannitol (or fructose) required for measurement of the boron concentration but also decreases the measurement accuracy. Economics are also discussed. (P.C.H.)

17568 (Y-1572) DETERMINATION OF SUBMICROGRAM QUANTITIES OF MERCURY IN WATER AND LITHIUM HYDROXIDE SOLUTIONS. Dill, M. S. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 28, 1967. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method has been developed for determining submicrogram quantities of mercury in water and lithium hydroxide. The detection limit is 2×10^{-4} micrograms per milliliter. The mercury is reduced to metal and then expelled from a solution as vapor. The vapor is measured using an atomic absorption spectrophotometer. (auth)

17569 (EURFNR-30F) CONTRIBUTION TO RESEARCH ON HYDROGENATED AND OXYGENATED IMPURITIES IN LIQUID SODIUM. Naud, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translation of report CEA-R-2583. 58p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

Thesis.

Methods for selectively determining the oxygenated and hydrogenated impurities present in sodium that is the oxide, hydride, and hydroxide, were investigated. These methods were then used to study the $Na-H_2-O_2$ system, as well as the related problem of the attack of pyrex glass by molten sodium. The conventional method for dosing oxygen by amalgamation was first adapted to the simultaneous measurement of the hydride. A method was then developed for dosing the total hydrogen by measuring successively the concentrations of gas present in the hydride and hydroxide form. This method is based on the thermal decomposition of the hydride and the reaction between sodium and the hydroxide. The reaction between hydrogen and sodium was studied in the temperature range from 150 to 250°C and at a pressure of about 150 mm of mercury. The thermal decomposition of the hydride in sodium was then stud-

ied. It was possible to make some qualitative observations concerning the reaction between sodium and sodium hydroxide. Finally some complementary tests made it possible to define the nature of the phenomena occurring during the sodium attack on pyrex glass. (auth)

17570 NEW CONTRIBUTIONS TO THE SPECTROGRAPHIC DETERMINATION OF IMPURITIES IN URANIUM BY THE METHOD OF FRACTIONAL CARRIER DISTILLATION. Capdevila, C. (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 63: 155-68(Feb. 1967). (In Spanish).

The carrier-distillation method for determination of impurities in uranium was modified in order to get a greater sensitivity. Electrodes 9.5 mm in dia with a crater 7 mm in dia and 10 mm deep were used. The elements considered were: Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, P, Pb, Si, Sn, Ti, and V, over the range from 0.01 to 30 ppM. Among the different carriers tested, AgCl and the mixtures (3:1) AgCl–AgF and (4:3) AgCl–Ga_2O_3 were chosen. The following experimental variables were studied: the concentration of carriers, the arc current, the size of the vent-forming tool, and the volatilization rates of every element. Palladium, indium, and silver were tested as internal standards. A standard deviation from ±9.5 to 18.5% is reported. (auth)

17571 SENSITIVITY AND ACCURACY OF NOMOGRAPHIC INTERPRETATION IN X-RAY FLUORESCENCE ANALYSIS. Niewodniczanski, Jerzy (Inst. of Nuclear Technology, Krakow). Nukleonika, 11: 725-34(1966).

A frequently used criterion of the "quality" of a radiometric method is the sensitivity of the method. It is shown that the use of the concept of sensitivity in nomographic interpretation of results in x-ray fluorescence analysis may lead to erroneous conclusions. A better criterion is said to be that connected with the error of determination. A way of determining this error and some examples of applications are given. (auth)

17572 TRACER AND RADIOACTIVATION STUDIES ON TARTAR EMETIC IMPURITIES. Alian, A.; Dessouky, Yehia M.; Shabana, R. (Atomic Energy Establishment, Inshas, Egypt). J. Pharm. Sci., 55: 969-71(Sept. 1966).

The problem of contamination of tartar emetic with arsenic and lead was examined using the radioisotopes ^{76}As and ^{209}Pb. Antimony potassium tartrate (tartar emetic) is a drug employed in the treatment of bilharziasis, schistosomiasis, leishmaniasis, filariasis, ascariasis, and other tropical parasite diseases. Toxicity after intravenous injection of this drug was reported and attributed to the presence of toxic impurities such as As and Pb. Neutron activation and radiochemical separation methods were developed for the determination of As and Pb concentration throughout the different stages of tartar emetic synthesis. It was shown that, while most of As is eliminated during the synthesis process, the major portion of Pb remains in the final product. It was also found that the 2 impurities can be eliminated by successive washing of the starting materials with 0.2M nitric acid and water. Tartar emetic synthesized from purified starting materials conforms to the requirements in pharmacopeias. (BBB)

17573 USE OF ION-EXCHANGE CHROMATOGRAPHY IN ACTIVATION-ANALYSIS DETERMINATION OF SODIUM AND POTASSIUM IN MOLYBDENUM AND TUNGSTEN. Doege, H.-G. (Institut fuer Metallphysik und Reinstmetalle, Dresden). Anal. Chim. Acta, 38: 207-11(May-June 1967). (In German).

A method for the determination of traces of sodium and potassium in molybdenum or tungsten by activation analysis is described. Radiochemically pure ^{24}Na and ^{42}K were separated from other radionuclides by anion- and cation-exchange chromatography. The limits of detection are 5 ppB of sodium and 50 ppB of potassium. (auth)

17574 NITROGEN DETERMINATION IN CERAMIC URANIUM COMPOUNDS. Naoumidis, A.; Nickel, H.; Rottmann, J.; Stoecker, H. J. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem., 226: 175-92(Feb. 15, 1967). (In German).

The procedure for determining the nitrogen content in ceramic uranium compounds is reported. UN_{1+x} ($0 \leq x \leq 0.80$) and U(C,N) compounds with high N_2 concentration as well as uranium carbides with nitrogen impurity content below 100 ppM were investigated, using modified conventional methods. Results are discussed in detail. The applicability of three analytical methods was confirmed by the agreement of the nitrogen results within the error limits. The coefficient of variation in the results yielded by the Dumas method, irrespective of the sample composition, was more favorable than that of the Kjeldahl method. The hot-extraction method also yielded exact results when UN_{1+x} compounds were analyzed. By applying both the Dumas and the Kjeldahl methods it was possible not only to determine quantitatively the nitrogen in nitride compounds but also the nitrogen in powdered materials, where it is possibly adsorbed in molecular form. (auth)

17575 PAPER ELECTROPHORETIC QUANTITATION AND MEASUREMENT OF THE RADIOACTIVITIES OF LABELED SULFUR AMINO ACIDS AS THEIR OXIDATION DERIVATIVES. Huovinen, Juho A. (Univ. of Helsinki). Acta Chem. Scand., 20: 2678-82(1966).

Performic acid treatment at 0°C for 16 hr quantitatively converted both free and protein-bound cysteine/cystine and methionine to cysteic acid and methionine sulfone. These acidic derivatives, in contrast to original neutral amino acids, are stable and more suitable for separation and quantitation. Most of performic acid was removed under reduced pressure at room temperature. Total hydrolysis was carried out in 6N hydrochloric acid at 100°C for 24 hr and the acid removed after filtration under reduced pressure at 40°C. The residue was dissolved in performic acid, evaporated to dryness in vacuo at room temperature and redissolved in 0.1N hydrochloric acid. Cysteic acid and methionine sulfone were separated by paper electrophoresis at pH 3.6 and 2.65, respectively. Paper strips are stained with cadmium-ninhydrin reagent, and colored fractions eluted and their optical densities measured at 505 nm. Duplicate strips stained with ninhydrin only are used for measurement of radioactivities direct on papers by liquid scintillation. (auth)

17576 SPECTROPHOTOMETRIC STUDIES OF URANIUM(VI)–PONGAMOL COMPLEX. Jain, B. D.; Purushottam, K. V. (Delhi Univ.). Proc. Indian Acad. Sci., Sect. A, 64: 245-8(Oct. 1966).

Spectrophotometric studies of uranium(VI)–pongamol complex were carried out in 50% aqueous ethanolic solutions. Pongamol produces a yellow complex with an aqueous uranyl salt solution and the complex is soluble in 50% aqueous ethanol. The complex is quite stable for 24 hours; the optical density remains constant at pH 5.6 to 7.1. The complex obeys Beer–Lambert's law at 390 mμ in the concentration range of 1 to 5 ppM of uranium in solution. The molar composition of the pongamol uranium(VI) complex was found to be 2:1, and its tentative structure suggested. The cations and anions that interfere in the estimation of uranium using pongamol are indicated. (auth)

17577 ACTIVATION ANALYSIS OF PHILIPPINE URANIUM ORES BY DELAYED NEUTRON COUNTING. Juliano, J. O.; Juliano, P. O. (Philippine Atomic Research Center, Diliman, Quezon City). Philippines Nucl. J., 1: No. 1, 9-16(July 1966).

Samples from the uranium deposit in Larap, Camarines Norte were analyzed by neutron activation and delayed neutron counting. The counting set-up and procedure are described in detail. The results of the analysis are compared with previous results obtained by radiometric analysis. (auth)

17578 RADIOMETRIC ANALYSIS OF P^*Cl_3 FOR THE IMPURITIES OF P^*OCl_3. Gorbachev, V. M.; Torgova, E. I. Radiokhimiya, 8: 710-11(1966). (In Russian).

Radiometric measurements were made of the phosphoryl chloride, P^*OCL_3, impurities present in the active P^*Cl_3(^{32}P, β, T = 14.3 days). The PCl_3 analysis was carried out considering the relative volatility of PCl_3 and $POCl_3$ microconcentrations in any inert solvent. The experiments used a special circulating device with trichloromethyl silane CH_3SiCl_3 ($T_{boil.}$ = 65.7°C). The magnitude of α_3 found for the CH_3SiCl_3–PCl_3 system was 1.17 and for CH_3SiCl_3–$POCl_3$ system was 2.3. With the presence of PCl_3 and $POCl_3$ in the solution the value α varied from 1.17 to 2.3. With the magnitude of α = 1.58, the weight of condensate Q_x = 1.19g, weight of cube liquid Q_γ = 19.4g, the estimated content of $POCl_3$ in the preparation was 48% with a relative error of 5%. (R.V.J.)

17579 MEASUREMENT OF RADIOACTIVITY FOR TRITIUM-LABELED ORGANIC COMPOUNDS. Wang, Lien-sheng. Hua Hsueh Tung Pao, No. 12, 38-41(Dec. 1963). (In Chinese).

Three simple and convenient methods of measuring the radioactivity for tritium-labeled organic compounds are described: gas chromatography, using a CBM-8 Geiger counter, and the thermal synthesis method. The distribution of tritium in the compound is also determined. These methods can be also applied to the separation, identification and measurement of radioactivity for ^{14}C, ^{35}S, and halogens. The gas chromatographic method was already used in ^{14}C determination. (JPRS)

17580 PRELIMINARY REPORT ON VERY-LOW-LEVEL POLONIUM DETERMINATION BY ELECTROCHEMICAL DISPLACEMENT. Abe, M.; Abe, S.; Watanabe, H. (National Inst. of Radiological Sciences, Chiba, Japan). Health Phys., 12: 1734-6(Dec. 1966).

The determination of polonium at very low concentrations was investigated. Several samples of test solution containing ^{210}Po were dropped on silver discs and dried naturally in air or under infrared lamps without exceeding 60°C. Other samples of test solution were used for plating by electrochemical displacement. The former samples, presumably prepared without loss showed original quantities; the latter showed deposited quantities. The

ratio of the latter to the former was recovery. The recovery percentage of polonium from standard solutions (HCl) at 10^{-14} to 10^{-13} Ci of ^{210}Po was better than 90%. (D.H.M.)

17581 TEMPERATURE-PROGRAMMED GAS–LIQUID RADIOCHROMATOGRAPHY OF FREE FATTY ACIDS. Smith, S.; Dils, R. (Univ. of Birmingham, Eng.). J. Pharm. Belg., 20: 225-33(May-June 1965).

Two methods are described for the analysis of radioactive mixtures of short- and long-chain fatty acids by gas-liquid radiochromatography. Commercially available polyester and phosphorylated polyester stationary phases were used in conjunction with temperature programming. To quantitate the recoveries of free fatty acids and their methyl esters, known amounts of radioactive fatty acids were carried through the extraction and methylation procedure. When analyzing a mixture of short-chain fatty acids as free acids, it was found that under the conditions necessary for adequate separation of short-chain fatty acids, the long-chain components had extremely long retention times. This was overcome by temperature programming. The complete analysis of a mixture of ^{14}C-labeled fatty acids on a poly(ethylene glycol adipate) column is described. A method was developed, which gives a good separation of a mixture of both short- and long-chain free fatty acids with symmetrical chromatogram peaks. Unsaturated free fatty acids can be separated from saturated free fatty acids of the same chain length and unsaturated isomers differing only in the position of the double bond can almost be completely separated. Branched-chain acids can also be separated from their corresponding straight-chain isomers. (BBB)

17582 GAS PURIFIER FOR PLASMA GENERATOR AND MASS SPECTROMETRIC ANALYSIS OF TRACE IMPURITIES. Chin, Kyon Ju (Japan Oxygen Co., Ltd.); Inoue, Nobuyuki. Shinku, 9: 398-404(Oct. 1966). (In Japanese).

The performance of an extremely pure gas supplier installed for the MACETIE in the Institute of Plasma Physics, Nagoya University, is described. In order to control the absolute amount of gas injected into the device, the purifier is equipped with precision pressure gages and thermometers. Mass spectrometric analysis of helium before and after purification was carried out using an ultrahigh vacuum analyzing chamber and CEC 21-614 residual gas analyzer. Impurities except hydrogen in helium were reduced from up to 400 ppM to less than 1 ppM by the liquid-nitrogen-cooled charcoal trap. Hydrogen could not be reduced at all. Precise analysis of commercial deuterium and hydrogen were also carried out, and compared with the specifications of manufacturers. (NSA of Japan)

17583 QUANTITATIVE PRECIPITATION OF TETRAVALENT URANIUM WITH SODIUM HYPOPHOSPHATE FROM STRONGLY ACID SOLUTIONS. Bloss, K. H.; Henzel, N.; Beck, H. P. (Battelle-Instituts e.V., Frankfurt am Main). Z. Anal. Chem., 226: 25-8(1967). (In German).

Sodium hypophosphate, $Na_2H_2P_2O_6 \cdot 6H_2O$, prepared by oxidation of red phosphorus, with sodium chlorite $NaClO_2$, is suitable to precipitate U^{4+} quantitatively at pH 1.5 to −0.5 (HCl or H_2SO_4 preferably), if the concentration of U^{4+} ranges above 5×10^{-3} moles per liter and that of phosphoric acid below 5% by weight. Only Ti^{4+}, Zr^{4+}, Hf^{4+}, and Th^{4+} are precipitated under these conditions, besides U^{4+}. Uranium can be determined as uranium(IV) hypophosphate (trihydrate) $UP_2O_6 \cdot 3H_2O$ (gravimetric factor 0.529) or as uranium(IV) pyrophosphate UP_2O_7 (gr. f. 0.578) after drying at 110°C or igniting (1000°C) in a furnace, respectively. In either case the method gave values easily reproducible within ±2%. Reclaiming of uranium(IV) from aqueous waste solutions can also be effected by precipitation as hypophosphate. (auth)

17584 DETERMINATION OF SMALL CONCENTRATIONS OF ZINC, NICKEL, AND IRON IN TITANIUM, ZIRCONIUM, AND THORIUM DIOXIDES AS WELL AS URANIUM IN THORIUM DIOXIDE BY X-RAY FLUORESCENCE ANALYSIS. Berthold, H. J.; Ankner, D. (Univ., Mainz). Z. Anal. Chem., 226: 13-16(1967). (In German).

Investigations on the determination of low concentrations of zinc, nickel, and iron in TiO_2, ZrO_2, and ThO_2 and of uranium in ThO_2 by means of x-ray fluorescence analysis showed that the calibration curves are linear for Zn, Ni, and Fe in TiO_2 in the investigated range of ≤0.1%, for Zn and Fe in ZrO_2 of ≤0.4%, for Ni in ZrO_2 of ≤0.1%, for Zn, Fe, and U in the ThO_2 ≤1.288% and for Ni in ThO_2 of ≤0.4%. The calculated limits of detections for a counting time of 5 min and 99.7% confidence are: TiO_2: Zn 0.001, Ni 0.001, Fe 0.003; ZrO_2: Zn 0.002, Ni 0.002, Fe 0.007; ThO_2: Zn 0.006, Ni 0.005, Fe 0.015, U 0.02 wt %. (auth)

17585 HIGH-PRECISION ANALYSIS OF NUCLEAR MATERIALS BY CONSTANT-CURRENT COULOMETRY. PART I. DETERMINATION OF URANIUM. Goode, G. C.; Herrington, J.; Jones, W. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Anal. Chim. Acta, 37: 445-54(Apr. 1967).

The application of constant-current coulometry for the highly precise and accurate assay of uranium and its compounds is reported. Uranium was reduced to the tetravalent state by titanium(III) in nitric acid solution containing sulfamate and reacted with excess of iron(III) to give an equivalent amount of iron(II), which was titrated with electrogenerated cerium(IV). Factors governing the overall titration efficiency are discussed and results for the assay of a number of standard uranium materials presented. The procedure gives a standard deviation of 0.004% at the 50-mg level and an accuracy exceeding 0.01%. (auth)

17586 ABSORPTIOMETRIC DETERMINATION OF MICROGRAM AMOUNTS OF URANIUM WITH RHODAMINE B. Moeken, H. H. Ph.; Van Neste, W. A. H. (EUROCHEMIC, Mol, Belg.). Anal. Chim. Acta, 37: 480-3(Apr. 1967).

Uranium(VI) can be extracted as a complex with rhodamine B into a benzene–ether–hexone solvent from a benzoate-buffered solution. Optimum conditions for the color development are defined, leading to a molar absorptivity of 102,700 $mmol^{-1}$ at 555 nm. The determination of uranium in the range 0.02 to 3 μg/ml in nitrate samples is described. The relative standard deviation ranged from 20 to 0.6%. The interference of several ions was investigated. (auth)

17587 THE DETERMINATION OF ZINC BY SUBSTOICHIOMETRIC ISOTOPE DILUTION. A NOTE. Stary, J.; Ruzicka, J. (Faculty of Technical and Nuclear Physics, Prague). Anal. Chim. Acta, 37: 541(Apr. 1967).

The effects of dithizone in the buffer-masking solution and oxalate on the determination of zinc by substoichiometric isotope dilution is discussed. The purification of the buffer-masking solution was performed most efficiently by extractive titration with very dilute solutions of dithizone so that only very small amounts of dithizone were transferred to the aqueous phase. Successive extraction with chloroform followed by storage in light rapidly decomposed the dithizone present in aqueous solution. It appears from the stability constant of zinc oxalate that oxalate ions in the concentrations used will not decrease the percentage extraction of zinc at pH 8.5 to 9.0 but the time of extraction must be increased. Since the standard and test solutions are always treated in exactly the same way in substoichiometric analysis, inaccurate results cannot be caused by any influence of the complexing agent. (D.H.M.)

17588 THE DETERMINATION OF BORON IN DILUTE AQUEOUS SOLUTIONS BY NEUTRON ACTIVATION ANALYSIS. Cassatt, Wayne A. Jr.; Estey, H. Paul; Slott, Ron (Washington State Univ., Pullman). Anal. Chim. Acta, 37: 545-8(Apr. 1967).

A method is described for the determination of boron in aqueous solutions by observing the (n,α) reaction on ^{10}B when the solutions are homogeneously mixed with liquid organic phosphors and placed in a thermal neutron flux. Experiments with a plutonium–beryllium neutron source embedded in a paraffin block showed that liquid scintillation pulses due to the recoiling (n,α) reaction products can be detected in the solution above a background of gamma rays and recoil proton pulses. Boron can be analyzed in the range of 1 to 10 mg/l by this method. (D.H.M.)

17589 ISOLATION AND IDENTIFICATION OF ATMOSPHERIC ^7Be. Poetzl, K.; Carnuth, W. (Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung, Garmisch-Partenkirchen, Ger.). Radiochim. Acta, 6: 133-5(Dec. 1966). (In German).

^7Be can be used as a tracer to measure the intensity of the atmospheric exchange through the troposphere. It is mainly formed just above the latter by cosmic-altitude radiation through interaction with atmospheric nitrogen and oxygen. To allow gamma-spectrometric determination ^7Be must be separated from fallout present in the air. A method of chemical separation, which works quantitatively and was developed especially to that purpose, is described. (auth)

17590 ELECTRON MICROSCOPIC PREPARATIONS OF RADIOACTIVELY LABELED AEROSOLS. Riedel, Guenter (Kernforschungsanlage, Juelich, Ger.). Staub, 23: 237-42(1963). (In German).

A method is described for the preparation and measurement of thickness of extremely thin layers of a nuclear emulsion on labeled electron microscope preparations. The emulsions can be observed after exposure and development in the electron microscope without further preparation. The source of the tracks formed in the emulsion can be identified and the size and structure determined. The method is applicable in dust research and in the analysis of medical and biological sections. Information about the properties of different emulsions is also included. (auth)

17591 APPLICATION OF ENERGY TRANSFER PHENOMENON TO GAS ANALYSIS. Imamura, Hiroshi; Oshima, Tokio

(Ube Industry, Ltd., Japan). FAPIG (Tokyo), No. 39, 262-3(Jan. 1966). (In Japanese).

A method is described for overcoming the difficulty of detecting gases such as CH_4, CO_2, and CO having a larger ionization potential than the carrier gas when Ar is used as the carrier. Addition of organic gases to the Ar improved the results. The energy is transferred from the metastable Ar^m to the organic gas, and the electric current decreased in proportion to the amount of the third gas present. The change in the discharge-initiating potential in the presence of Ar^m was also studied. When the decrease in electric current is used as the criterion of determination, an organic gas giving a large ionization current should be used to give rise to its saturation value. When the increase of the discharge-initiation potential is used, an organic gas causing a large decrease in the potential should be added to give the smallest discharge potential. (NSA of Japan)

17592 CALIBRATION OF FLOW-THROUGH DETECTORS OF ^{14}C IN GAS-LIQUID CHROMATOGRAPHIC EFFLUENTS. Karmen, Arthur (Johns Hopkins Univ., Baltimore). J. Lipid Res., 8: 61-3(Jan. 1967).

A technique and device were developed to deliver a steady flow of $^{14}CO_2$ to the gas-liquid chromatographic column for calibration. The $^{14}CO_2$ is generated from $NaH^{14}CO_3$, used as a solution in 0.1N NaOH. Microliter quantities of this solution can then be assayed by liquid scintillation counting. The CO_2 can readily be released from similar aliquots by injecting them into an acid solution. The bicarbonate solution can thus serve as a convenient source of $^{14}CO_2$. A metered flow of carrier CO_2 from a simple generator was bubbled through the acid solution in the tube, 3 ml of 1.0M NaH_2PO_4. The outlet tube was connected to a moisture trap, the effluent of which was delivered either directly to the detector or to some point in the gas line leading to the detector. This ability to introduce known samples of radioactive gas repeatedly and reproducibly was particularly helpful in determining the voltage and discriminator settings for flow-through proportional counters and scintillation counters. (BBB)

17593 AN IMPROVED METHOD FOR LIQUID SCINTILLATION COUNTING OF BIOLOGICAL MATERIALS. Miyazaki, Hisashi; Minaki, Yasuo; Yoshimura, Yoshio (Dainippon Pharmaceutical Co., Ltd., Osaka). Chem. Pharm. Bull. (Tokyo), 14: 1298-9(1966).

A procedure was developed using an ethanolic potassium hydroxide system for the liquid scintillation counting of the biological materials. The method involves the digestion of the sample with ethanolic KOH and solubilization in Bray's dioxane scintillator solution by addition of ethylene glycol after decolorization with hydrogen peroxide. Since the entire preparation procedure can be performed in the counting vial, this method is suitable for determining the radioactivity of many samples at once. A large quantity of biological material (up to 200 mg of animal tissues) can be easily dissolved and counted with satisfactory efficiency. No separation of the liquid phases is evident even at low temperatures. Therefore, accurate determination of the radioactivity is possible for samples with low activity by increasing the amount of material used. Counting efficiencies obtained with ^{14}C and ^{35}S for various tissues are shown. (TSS)

17594 CALCIUM ACTIVATION IN THE DETERMINATION OF THE DISTRIBUTION OF CEMENT IN CONCRETE. Prickartz, Rainer. Bauingenieur, 41: 338-9(1966). (In German).

The irradiation of concrete samples with thermal neutrons causes production of ^{49}Ca, which may be used as a measure of the cement content, provided that the concrete contains no other Ca-containing component. The ^{49}Ca γ emission is 3.09 MeV. Only traces of ^{37}S are usually present in cement. To avoid interference, any O produced during activation can be permitted to decay before the 8.9-min ^{49}Ca is measured, because ^{19}O has a half-life of only 29.4 sec. The equipment used for the activation consists of a (Be,d) neutron source and paraffin moderator, and the activity of the concrete sample is measured by a G-M or scintillation counter. The pulse rate measured is proportional to the cement concentration of the concrete sample. To eliminate the effects of differences in intensity of the neutron flux during activation and from sample to sample, an In foil is irradiated along with the concrete sample. The count from this is used to correct the count from the concrete sample. By taking random triplicate samples from concrete its homogeneity can be established. The accuracy of this procedure is within ±10% of a chemical analysis. (BBB)

17595 SOME RAPIDITY CRITERIA OF NEUTRON-ACTIVATION ANALYSIS. Kartashev, E. P.; Nikolaenko, O. K.; Danil'chenko, I. D.; Gambaryan, R. G.; Shtan', A. S.; Bobrov-Egorov, N. N. At. Energ. (USSR), 22: 54-5(Jan. 1967). (In Russian).

From the formula on induced activity, the characteristic constants of the elements, such as the activation cross section, $\sigma_{act.}$, concentration of the isotope in the natural isotopic mixture, p, Avogadro's number N_A, and the atomic weight of the element A_{el}, the following correlation may be obtained: $A = f\sigma_{sp}mS$. In this equation f designates the neutron-flux density, $\sigma_{sp} = \sigma_{act}N_A p/A_{el}$ or the activation cross section per 1 g of the element, and m is the mass of the element, S being the saturation factor. However, the specific activation cross section does not include a time factor and therefore it cannot be used to determine whether an element may be determined by activation if saturation is not reached. If the time of irradiation, $t_{irr} \ll T_{\frac{1}{2}}$, the induced activity may be expressed as $A = 0.693\ fm\ F_{speed}t_{irr}$. It is proposed to designate the factor F_{speed} as the speed factor, as it characterizes the buildup of the activity. The factor was calculated and presented in tabular form for 27 isotopes. The table allows the selection of the elements best suited for express activation analysis. (TTT)

17596 SIMPLIFIED PRECISION COULOMETRY. Eckfeldt, Edgar L.; Shaffer, E. W. Jr. (Leeds and Northrup Co., North Wales, Pa.). 17p. (CONF-651004-18). DTIE.

From 9th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

A survey of recent developments in thinking concerning the use of precision coulometry for solution standardization in analytical procedures is presented. Three types of coulometric cells, a four-compartment cell, a shield type cell, and a counterflow cell, are discussed. Results of standardization of potassium hydrogen phthalate and constant-boiling HCl are compared with results obtained with usual titrimetric methods. In both cases, the coulometric results were slightly higher. The speed of the coulometric method over conventional titrimetric methods is emphasized. (B.L.M.)

17597 QUANTITATIVE ASPECTS OF SPARK SOURCE MASS SPECTROMETRY. Harrington, William Lewis. Ithaca, N. Y., Cornell Univ., 1966. 108p.

Thesis.

The potential capabilities of spark source mass spectrometry were not fully realized due to difficulties encountered in obtaining consistent, accurate data representative of sample composition. Some of the sources of error and the necessity for rigid control of analytical procedure, instrument parameters, and sample environment are stressed. The GRAF-2 double-focusing spark source mass spectrograph is described, and an approach toward optimization and control of instrumental functions are given in order to point out some of the factors involved in producing a mass-resolved signal that could be quantitatively related to sample composition. A major improvement in control of sample environment is achieved through the use of a cryosorption pump placed in the source chamber near the sparking sample. The fast pumping speed and large capacity of this simple pump allows rapid pump-down to low source pressure, maintains lower pressure during sparking, and eliminates hydrocarbon interferences previously observed in all spectra. The effectiveness of these approaches was demonstrated by application to two analytically significant problems. NBS standard iron samples were used to demonstrate increased precision and accuracy for the determination of a large variety of impurity elements. An average precision and accuracy for the determination of 22 impurity elements (including metals, nonmetals, and interstitials) in the ppM range was ±20% for a single mass spectrographic analysis. Reduction of the instrument blank for C, O, and N to less than 0.5 ppM by cryosorption pumping allowed the simultaneous determination of trace amounts of these elements in a variety of metal matrices. Prevention of blank fluctuations and the microsampling of the rf spark allowed the use of precision of replicate exposures at different sample locations as an indication of impurity distribution and sample homogeneity. (Dissertation Abstr.)

17598 AUTOMATION IN ANALYTICAL CHEMISTRY. Technicon Symposia Held at New York, Sept. 8–10, 1965, and London, Oct. 11–13, 1965. Skeggs, Leonard T. Jr. (ed.). New York, Mediad Inc., 1966. 740p. (CONF-650919).

One hundred sixty applications of the continuous flow method of analysis are described. Applications of automatic methods in the following fields are included: pharmaceutical research, process and quality control; foods and beverages; agricultural chemistry; metallurgical analysis; general industrial; power station chemistry; pollution and water analysis; clinical chemistry; multiple analytical techniques, data processing, health screening procedures; vivo techniques; immunology, hematology, and serology; enzyme research and analysis; and chromatography. Separate abstracts were prepared for 3 papers; 2 papers were previously abstracted for NSA 19: 40405 and 40406. (D.H.M.)

For abstracts of individual papers see: 17599–17601.

17599 AUTOMATED PROCEDURE FOR H_3BO_3 ANALYSIS IN WATER. Demmitt, T. F. (Battelle-Northwest, Richland,

Wash.). pp 204-6 of Automation in Analytical Chemistry. Skeggs, Leonard T. Jr. (ed.). New York, Mediad Inc., 1966.

An inverse colorimetric analysis procedure was developed, and an automated sample-handling system was designed, to permit continuous measurement of trace concentrations of H_3BO_3 in water The integrated system was used for online monitoring of H_3BO_3 in the Plutonium Recycle Test Reactor moderator under actual process conditions. The results obtained confirmed the suitability of the sample-handling and analysis techniques employed. (auth)

17600 AUTOMATED PROCEDURE FOR ZIRCONIUM ANALYSIS IN WATER. Demmitt, T. F. (Battelle -Northwest, Richland, Wash.). pp 207-9 of Automation in Analytical Chemistry. Skeggs, Leonard T. Jr. (ed.). New York, Mediad Inc., 1966.

A technique for automating differential fluorescence analysis procedures was developed. The technique was used to adapt an existing manual procedure for zirconium analysis in water for continuous operation. The procedure can be used to monitor zirconium concentrations in the ppB range. The procedure may eventually be suitable for detecting accelerated corrosion of zirconium and zirconium alloys in water environments. (auth)

17601 POTENTIOMETRIC PROCESS MONITOR FOR NITRITE DETECTION: A FEASIBILITY STUDY USING THE AUTOANALYZER. McGowan, C. R.; Woolley, D. T. (United Kingdom Atomic Energy Authority, Sellafield, Eng.). pp 228-31 of Automation in Analytical Chemistry. Skeggs, Leonard T. Jr. (ed.). New York, Mediad Inc., 1966.

An in-line instrument for the detection of nitrite ion in a plant for the chemical reprocessing of irradiated uranium fuel is described. An autoanalyzer was used in the potentiometric monitoring for nitrite. In order to prevent the disappearance of nitrite the sample is treated with ferrous sulfamate to destroy a definite amount of nitrite; when the difference between the original sample and the treated sample reaches a predetermined level, an alarm is triggered. (D.H.M.)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 17564, 17569, 17733, 18237, 18268, 18313, 18348, and 19117.

17602 (AD-637661) THE IONIZATION OF WATER, METHYLAMINE, AND METHYL ALCOHOL, USING ELECTRON AND ION IMPACT. Sjogren, H. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). May 10, 1966. Contract AF 61(052)-762. 34p. (AFCRL-66-593). CFSTI $3.00 cy, $0.65 mn.

The ionization of H_2O was investigated, using charge exchange in a double mass spectrometer. The breakdown graph was constructed. A break in the electron impact ionization efficiency curve is explained as being due to preionization, as its explanation as being due to an ion-molecule reaction between H(+) ions and H_2O seems to be less probable. The appearance potential of OH(+) was found to be considerably higher with charge exchange than when electron impact was used, which agrees with an earlier finding that intercombination transitions seem to be more strictly forbidden in charge exchange than in electron impact. CH_3NH_2 and CH_3OH were investigated, using charge exchange at elevated pressures. The breaks in the ionization efficiency curves for these molecules are discussed and ascribed to preionization or secondary processes. (auth)

17603 (COO-347-28) THE CHEMISTRY AND NUCLEAR CHEMISTRY OF THE HEAVY ELEMENTS. Annual Report, February 1966-January 1967. Cobble, J. W. (ed.) (Purdue Univ., Lafayette, Ind. Dept. of Chemistry). Feb. 1, 1967. Contract AT(11-1)-347. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: ternary fission in ^{238}U, ^{235}U, and ^{232}Th; ternary and binary fission in ^{238}U; charge distribution in ^{237}Np and ^{239}Pu fission; mass distribution in ^{237}Np and ^{239}Pu fission; fission excitation functions of Re, Lu, and Tm; fission of Ir and Re; search for polymeric neutrons; neutron emission in charged particle reactions; entropy of the neptunyl ion; potential of the NpO_2/NpO_2^+ electrode; thermodynamics of Pu^{3+} (aq.); magnetic entropy of aqueous rare earth ions; and development of low level γ-γ coincidence counter. (P.C.H.)

17604 (IS-T-154) THERMAL AND MAGNETIC STUDIES OF LIGAND FIELD LEVELS IN CESIUM COPPER CHLORIDE-$CsCuCl_3$. Rioux III, Frank Joseph (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The heat capacity and magnetic susceptibility of powdered $CsCuCl_3$(s) have been measured in the range 5 to 300 and 1.3 to 140°K, respectively. The susceptibility above 60°K fits a Curie-Weiss law $\chi = C/T - \Theta + \alpha$ c.g.s.u./mole with $C = 0.470 \pm 0.005$, $\Theta = 4.23 \pm 0.05$, and $\alpha = 400 \times 10^{-6}$. An MO model invoking D_4h symmetry in which the unpaired electron is in a B_{1g}^* orbital has been used to fit the susceptibility. The susceptibility departs from Curie-Weiss behavior below 60°K, becoming constant below 10°K, and a co-operative transition is found in the heat capacity at 10°K. The thermodynamic functions are tabulated to 300°K. The following values were found: $S^0_{298.15} = 214.192$ J/mole deg, $H^0_{298.15} - H^0_0 = 93.072$ J/mole deg. (auth)

17605 (LA-DC-7486) FURTHER TESTS OF DILUTE SOLUTION EQUATIONS AND THERMODYNAMIC RELATIONSHIPS. I. THE VAPOR PRESSURE OF CADMIUM OVER LIQUID ALLOYS CONTAINING SMALL AMOUNTS OF LEAD. Swofford, Harold S. Jr.; Elliott, Guy R. B. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Cadmium solvent vapor pressures at 780°K over solutions containing 0.004 to 0.01 mole fraction lead show strong negative deviations from Raoult's law and obey the pressure-composition relationship $P_{Cd\ alloyed}/P_{Cd\ pure} = 1 - 1.63\ N_{Pb}$ where N_{Pb} is the mole fraction of lead in solution. At larger lead concentrations an increasing curvature becomes observable, and from 0.015 to 0.032 mole fraction lead the relationship $P_{Cd\ alloyed}/P_{Cd\ pure} = 1 - 2.04\ N_{Pb} + 33.0\ N_{Pb}^2$ is obeyed, the activity becoming positive to Raoult's law at 0.9683 mole fraction cadmium. The nonunit coefficients of the first order terms in the solute mole fraction support the concept of nonideal interactions upon the solvent by the solute. This is a further experimental indication that Raoult's law need not be obeyed although the solute atoms are widely separated. (auth)

17606 (NP-16610) ETUDE DES HYDRURES D'ERBIUM ET D'YTTRIUM. (Study of Hydrides of Erbium and Yttrium). Note Technique Acc. 65-06. Maurin, J. F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Feb. 1965. 30p. (In French). Dep. mn.

Kinetics of the absorption of H_2, deuterium, and tritium by Er and Y were studied, and the results obtained are graphed. From the absorption curve it was not possible to derive an absorption law. However it was established that temperature increase is followed by an increase in the absorption velocity. The absorption velocity is connected with the thickness of the metallic layer deposited. The aging of the metallic deposit on the support caused a decrease in the final gas/metal atomic ratio. A thermodynamic study was made to determine stability conditions for the Er-H_2 system and relation between pressure, temperature, and composition for this system. The isothermal curves obtained had three distinct regions. In the first region the pressure and composition augment together up to a certain value which corresponds to the solubility limit of the H_2 in the metal. This region is a single phase solid solution of H_2 in Er. The second region consists of a series of plateaus corresponding to the metal-hydride equilibrium. If the pressure is constant the system becomes univariant and corresponds to the existence of two phases. The third branch is analogous to the first and the pressure and composition increase rapidly. This indicates the existence of an hydride phase and corresponds to the saturation with H_2 of the hydride limit given by the extremity of the plateau. (J.S.R.)

17607 (NYO-2082-9) ANALYSIS OF EXPERIMENTAL DATA ON VISCOSITY AND SELF-DIFFUSION OF LIQUID METALS AND THEIR CORRELATION BY A SIMPLE KINETIC THEORY OF LIQUIDS. Grosse, A. V. (Temple Univ., Philadelphia, Pa. Research Inst.). Nov. 7, 1966. Contract AT(30-1)-2082. 57p. (RITU-1966-30). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Measurements were made on viscosity for 27 metals and diffusion for 9. The experimental results were found to be in good agreement with elementary theory of viscosity and diffusion. It was concluded that the viscosities and diffusion coefficients of any metal can be calculated if the metal's melting point, atomic volume at the melting point, and Debye temperature are known. The elementary theory of viscosity and self-diffusion is briefly discussed. (P.C.H.)

17608 (ORO-3518-3) EXCHANGE CURRENT MEASUREMENTS ON THE NICKEL-NICKEL(II) COUPLE IN MOLTEN FLUORIDES. Mamantov, Gleb; Jenkins, H. W.; Manning, D. L. (Tennessee Univ., Knoxville. Dept. of Chemistry. Oak Ridge National Lab., Tenn.). Jan. 5, 1967. Contract AT(40-1)-3518. 5p. (CONF-670401-7). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 153rd National Meeting, American Chemical Society, Miami Beach, Fla.

A relaxation method was used to study the kinetics of the Ni^{2+} + 2e Ni process in molten $LiF-BeF_2-ZrF_4$ (65.6 to 29.4 to 5.0 mole

%) at 497°C. From the plot of log i_o (exchange current) vs log Ni (II), the transfer coefficient α was calculated as 0.23 (the slope is $1-\alpha$). The standard rate constant, k^o, was found to be approximately 3.2×10^{-3} cm/sec, using the relation $i_o = nFk^o C^{1-\alpha}_{Ni(II)}$. Exchange current data are tabulated. (P.C.H.)

17609 (TID-23757) P-V-T RELATIONS IN HIGH MOLECULAR WEIGHT AROMATIC HYDROCARBONS. Final Report. Schmidt, Hartland; Opdycke, Jack; Clark, Ronald K.; Gay, Charles F. (California Univ., Riverside). Sept. 1966. Contract AT-(11-1)-34. 138p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: structural effects and properties of oligomers of interest in separations and statistical thermodynamics of liquid polyphenyl chain molecules and their mixtures. The contributions of the chain length, chain structure, internal rigidity, segment potential function, and combinatorial configurational entropy to the properties of liquid short chain molecules and their mixtures, as exemplified by the polyphenyl series, were found to be significant in terms of general models of simple chain molecules. The pressure-volume-temperature properties of liquid benzene and 1,3,5-triphenylbenzene were measured. Volume data were fit to an equation containing terms up to quartic in temperature and quadratic in pressure and to the Tait equation. Data on biphenyl, m-, o-, and p-terphenyl were also fit to the equations. Data on polyphenyls were then treated by the statistical thermodynamic corresponding states models. The infinite dilution thermodynamic properties of benzene-polyphenyl systems were investigated by means of gas-liquid chromatography. Combination of the results yielded information on intermolecular potential energy interactions between segments on the different molecules present in the mixture. (P.C.H.)

17610 (UCRL-16410) THE ELECTRON SPIN RESONANCE SPECTRA OF THE RADICAL ANIONS OF SEVERAL 1,3-DIENES. Levy, Donald H.; Myers, Rollie J. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 1965. Contract W-7405-eng-48. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The ESR Spectra of radical anions of 2,3-dimethyl-1,3-butadiene, 1,3-cyclohexadiene, and isoprene were examined in liquid ammonia. The proton hyperfinc interaction can be readily assigned except for the case of isoprene where there is a small discrepancy between the assignment and the observed spectrum. In the case of 2,3-dimethyl-1,3-butadiene two distinct CH_2 coupling constants were observed as might be possible for the radical anion in either a cis or trans conformation; Hückel theory with the inclusion of hyperconjugation was in good agreement with the observed proton coupling constants. (auth)

17611 (UCRL-16418) QUANTITATIVE DIFFERENTIAL THERMAL ANALYSIS... ? Nicholson, Patrick S.; Fulrath, Richard M. (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 29, 1965. Contract W-7405-eng-48. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In studies on the effective thermal conductivity of a powder-gas mixture, the values obtained were greatly influenced by the gaseous species. This factor was not previously appreciated in quantitative differential thermal analysis techniques. The size and shape of the differential thermal analysis peak associated with a reaction involving a gas phase will be influenced by the heat transfer characteristics of that gas. (auth)

17612 (UCRL-17401) THERMODYNAMICS OF SOLID AND LIQUID AuSn AND HEAT CONTENTS OF GOLD AND TIN. Plaza, Elias Meyer (California Univ., Berkeley. Lawrence Radiation Lab.). Feb. 1967. Contract W-7405-eng-48. 44p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Using a diphenyl ether drop calorimeter, high temperature heat contents, $H_T - H_{298.15}$, of gold, in the range 404 to 1486°K; tin, in the range 405 to 924°K; and AuSn, in the range 416 to 917°K, have been measured. Smooth curves have been drawn through the experimental points, within a scatter of ±20 cal/g. atom, joining smoothly with data at low temperatures. Heats of fusion have been derived and tables of smoothed heat contents are presented. The data have been used to calculate the heat of formation of the alloy AuSn as a function of temperature, taking as a basis the heat of formation at 273°K. The agreement obtained with heats of formation at 623°K and at 696°K previously reported was within 45 cal/g. atom, which is much less than the combined experimental uncertainties of the heats of formation and present data. This resolves discrepancies of 300 cal/g. atom or more, which existed among the mentioned heats of formation when previously available data for heat contents of AuSn were used. This is the significant evidence that indicates that the previous heat content data for AuSn were not accurate. (auth)

17613 (ORNL-tr-1641) INORGANIC CHEMISTRY: ON THE EXISTENCE OF A HIGHER VALENCE OF CURIUM IN SOLUTION. CRITICAL STUDY OF OXIDATION BY OZONE. Pages, Monique; Demichelis, Rene. Translated for Oak Ridge National Lab., Tenn., from Compt. Rend., Ser. C, 263: 938-40(1966). 4p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

Experiments were made on the adsorption of Cu and Gd on an anionic resin treated by ozone in order to check on previously published results (Akatsu, J., Radiochim. Acta 4: 58 (1965)) on the existence of a higher valence of Cu in solution. The results showed that there is no oxidation of ^{244}Cm, but a degradation of the anionic resin. (P.C.H.)

17614 DETERMINATION OF THE ACTIVITY COEFFICIENT AT 1600°C OF URANIUM IN INFINITELY DILUTE SOLUTION IN LIQUID IRON BY THE STUDY OF HETEROGENEOUS EQUILIBRIUM. Gatellier, Christian; Allibert, Michel; Olette, Michel (Institut de Recherches de la Siderurgie Francaise, Saint-Germain-en-Laye, France. CNRS-ENS, Grenoble, France). Compt. Rend., Ser. C, 264: 429-32(Jan. 30, 1967). (In French).

A study of the heterogeneous equilibrium, at 1600°C, between aluminum and uranium dissolved in liquid iron and the oxides of these two elements permitted the determination of the activity coefficient in infinitely dilute solution, γ^0_U, the coefficients of interaction ϵ^U_U and ϵ^{Al}_U, and the free enthalpy of dissolution, ΔG^0_U, of uranium in iron at this temperature. (tr-auth)

17615 SOME COMPLEXES OF DIHYDROXYURANYL WITH UREA AND ITS ALKYL DERIVATIVES. Dembinski, W.; Deptula, A. (Inst. of Nuclear Research, Warsaw). J. Inorg. Nucl. Chem., 29: 799-807(Mar. 1967).

The ir spectra indicate that $H_2O \cdot UO_3 \cdot 2CO(NH_2)_2$ should be regarded as a complex compound of dihydroxyuranyl with a neutral ligand, $UO_2(OH)_2 \cdot [CO(NH_2)_2]_2$, and not as a salt of uranic acid $(CONH_2NH_3)UO_4$. A similar complex with methylurea was obtained. Attempts to obtain complexes with 1,3-dimethylurea, tetramethylurea, ethylurea, 1,3-diethylurea, and thiourea failed. (auth)

17616 ISOTOPE EFFECTS. Borcic, Stanko; Sunko, Dionis (Ruder Boskovic Inst., Zagreb). Nukl. Energ., 3: 13-16(1966). (In Slovak).

One of the aspects of the application of isotopes is the measurement of isotope effects. A description of the phenomenon of the isotope effects is given, followed by an explanation in terms of quantum mechanics. Emphasis is given to hydrogen isotope effects and occurrence of the "tunnel effect" is discussed. A definition of primary and secondary isotope effects is given. The use of isotope effects in elucidation of reaction mechanisms is illustrated on a few examples. Isotopic substitution represents the "least possible change" of a system and the measurement of isotope effects is a powerful tool in this sort of investigation. (auth)

17617 NATURAL EQUILIBRIUM DISTRIBUTION OF METHANE AND THE DEUTEROMETHANES. Apse, J. I.; Missen, R. W. (Univ. of Toronto). J. Chem. Educ., 44: 30-1(Jan. 1967).

Determination of the distribution of methane and the 4 deuteromethanes at equilibrium and with natural H to D abundance is described. The free energy data required were put in the form of equilibrium constants for the relevant equations. The constants are based on statistical calculations in the ideal-gas state, and are given at 7 temperatures over the range from −180 to 1000°C. For a system containing the 5 species CH_4, CH_3D, CH_2D_2, CHD_3, and CD_4, it was shown that 3 equations are required to represent the stoichiometry. The equilibrium constants and mole fractions for these equations were calculated. The calculations confirmed that virtually all the D is present in the form of CH_3D. The concentration of 624 ppM found is about the same as obtained by analysis of natural gas samples if it is assumed that all the D is present in this form. The relative amounts of CH_4 and CH_3D, being much greater than the others, are governed by the H to D ratio and not by equilibrium considerations. As such, they are independent of temperature, as was shown. The relative amounts of the other 3 species increase rapidly as the temperature decreases below 25°C, although they are still negligibly small at −180°C. These calculations refer to the distribution dictated by the natural abundance of H to D. Higher concentrations of the deuteromethanes can be obtained if an artificial or enriched D to H ratio is used. (BBB)

17618 DECOMPOSITION OF URANYL CHLORIDE AND ITS INTERACTION WITH DIOXIDE OF URANIUM IN MELT NaCl-KCl. Smirnov, M. V.; Komarov, V. E.; Koryushin, A. P. At. Energ. (USSR), 22: 30-3(Jan. 1967). (In Russian).

The thermal decomposition of uranyl chloride and its interaction with uranium dioxide in the chloride melt NaCl-KCl was investigated. It was shown that the decomposition products of uranyl chloride and the products of its interaction with uranium dioxide

are mixed oxides and uranium tetrachloride. An explanation of the nonstoichiometric cathode precipitation of uranium dioxide obtained during the electrolysis of chloride melts containing uranyl ions was given. (tr-auth)

17619 GAS-CHROMATOGRAPHIC STUDIES OF THE SYSTEM URANYL NITRATE + TBP + DILUENT + WATER. Apelblat, A.; Hornik, A. (Atomic Energy Commission, Negev, Israel). Trans. Faraday Soc., 63: 185-94(Jan. 1967).

Activity coefficients and excess thermodynamic functions at infinite dilution were determined in the binary systems: diluent + solvate of uranyl nitrate, diluent + TBP, diluent + dodecane, and in the ternary system diluent + dodecane + TBP. Gas chromatography was used. The results agree well with vapor pressure measurements and solubility data. Particular attention was directed to the behavior of water in these systems. The diluents used were benzene derivatives, paraffins, halogen-substituted hydrocarbons, cyclohexane, acetone, dioxane and carbon disulphide. The connection between the non-ideality of the organic phase and extraction equilibria is discussed. (UK)

17620 ORGANIC COMPOUNDS OF URANIUM. REACTIONS OF URANIUM PENTAETHOXIDE WITH β-DIKETONES. Bhandari, A. M.; Kapoor, R. N. (Univ. of Jodhpur, India). Austral. J. Chem., 20: 233-7(Feb. 1967).

The reactions of uranium pentaethoxide with β-diketones (2,4-pentanedione and 1-phenyl-1,3-butanedione) were studied and derivatives of the type $U(OEt)_{5-x}L_x$ (where L = acetylacetone or benzoylacetone; x = 1, 2, or 3) were isolated. These derivatives interchanged their ethoxy groups with tertiary butoxy groups on refluxing with t-butyl alcohol. The molecular weights and boiling points of some of the typical derivatives were determined and recorded. (auth)

17621 NEUTRON-DIFFRACTION STUDY OF YOOD. Christensen, A. Noerlund (Univ. of Aarhus, Denmark); von Heidenstam, Olov. Acta Chem. Scand., 20: 2658-62(1966).

Hydrothermal methods were used to prepare yttrium oxide deuteroxide, YOOD. The compound is monoclinic with two formula units in the cell. The space group is $P2_1/m$ with a = 5.95 Å, b = 3.65 Å, c = 4.30 Å, and β = 109.1°. The position of the deuterium atom in the structure was determined from neutron-diffraction powder data. The structure is not hydrogen bonded. (auth)

17622 STUDY OF THE ISOTOPIC DISPROPORTIONATION REACTION BETWEEN LIGHT AND HEAVY WATER USING A PULSED-MOLECULAR-BEAM MASS SPECTROMETER. Pyper, J. W.; Newbury, R. S.; Barton, G. W. Jr. (Univ. of California, Livermore). J. Chem. Phys., 46: 2253-7(Mar. 15, 1967).

Isotopic exchange equilibrium in the disproportionation reaction $H_2O + D_2O = 2\ HDO$ was studied at 0 and 25°C and over a range of deuterium compositions using a pulsed-molecular-beam mass spectrometer. The equilibrium constant K was found to be 3.75 ± 0.07 at both temperatures. The pulsed-beam mass spectrometer was shown to be effective in minimizing the "memory effect" in the mass spectrometer. The experimental K is shown to be consistent with equilibrium constants for similar isotopic disproportionation reactions and with current theory. (auth)

17623 INFRARED SPECTRUM OF DEUTERIUM SULFIDE. Miller, R. E. (Princeton Univ., N. J.); Leroi, G. E.; Eggers, D. F. Jr. J. Chem. Phys., 46: 2292-7(Mar. 15, 1967).

The bending fundamental (ν_2) of D_2S was investigated under high resolution. Centrifugal-distortion corrections were applied in the rotational analysis, and transition intensities were computed in both the rigid-rotor approximation and with the inclusion of classical centrifugal distortion. The inertial constants arising from this analysis for the ground state are A = 5.484, B = 4.508, C = 2.444; for the excited state they are A′ = 5.616, B′ = 4.585, C′ = 2.421$_8$ cm^{-1}, and the ν_2 band center is 855.45 cm^{-1}. These results together with information derived from previous investigations of D_2S and H_2S were used to evaluate the constants in the quadratic expression for the vibrational energy levels and to compute some of the constants in the general expressions for the moments of inertia as a function of vibrational quantum numbers. The experimental values of the inertia defect for the ground state and the ν_1 and ν_2 excited states are in good agreement with those predicted theoretically. (auth)

17624 EFFECT OF DEUTERIUM SUBSTITUTION ON ESR LINEWIDTH PARAMETERS. Forbes, W. F.; Sullivan, P. D. (Univ. of Waterloo, Ont.). J. Chem. Phys., 46: 2445-6(Mar. 15, 1967).

Measurements were made of the ESR spectra of duroquinol cation radicals in concentrated H_2SO_4 and D_2SO_4. The observed a_{CH}/a_{CD} ratio (6.17 ± 0.03) was ~5.0% lower than the ratio of the magnetic moments. Linewidth parameters were plotted against temperature. (M.C.G.)

17625 MIRROR SYMMETRY AND NATURE OF ELECTRON ABSORPTION SPECTRA OF URANYL COMPOUNDS. I. Seuchanka, A. N.; Umreika, D. S. Vestsi Akad. Navuk BSSR, Ser. Fiz.-Tekh. Navuk, No. 3, 37-44(1963). (In Belorussian)

Plots of data on separation force and absorption coefficients at different frequencies for aqueous and acid solutions of various uranyl compounds and a uranyl melt showed a definite Boltzmann distribution of UO_2 groups in the excited state. This was not shown for crystalline UO_2 salts. The thermal distribution of excited molecules was found to be close to calculated values for all the dissolved compounds studied. The shapes of the calculated and measured absorption spectra coincided only in the first 1½ to 2 bands. When the spectrum for each of the studied compounds was separated into two regions by the mirror symmetry method, the frequency interval between the maximum bands was found to be practically constant. Both separated spectra were made up of bands at about equal distances from each other, as is observed in luminescence spectra. The small change in the frequency interval with increase in quantum vibration number results from small anharmonic vibrations in the uranyl ion. (TTT)

17626 ISOTOPIC EXCHANGE REACTIONS. PART II. EXCHANGE OF CHLORINE BETWEEN ACETYL CHLORIDE AND CADMIUM CHLORIDE. Desai, K. K.; Haldar, B. C. (Inst. of Science, Bombay). J. Indian Chem. Soc., 43: 734-6(Dec. 1966).

The exchange of chlorine between liquid acetyl chloride and cadmium chloride, though rapid, is not complete. This is explained as due to the incomplete formation of a solid compound of the type $(CH_3CO)^+ (CDCl_3)^-$, which acts as a protective film on the surface of cadmium chloride hindering further reaction between unreacted cadmium chloride and acetyl chloride. Complete exchange of chlorine occurred when benzyldimethylphenylammonium chloride was added to the reaction mixture. (auth)

17627 PLUTONIUM AND URANIUM HEXAFLUORIDE HYDROLYSIS KINETICS. Kessie, Robert W. (Argonne National Lab., Ill.). Ind. Eng. Chem., Process Design Develop., 6: 105-11(Jan. 1967).

The hydrolysis rates of gaseous plutonium hexafluoride and uranium hexafluoride were measured in a packed bed at room temperature. The reaction product was solid plutonyl fluoride (PuO_2F_2) or uranyl fluoride (UO_2F_2), respectively. At low concentrations of the hexafluorides in the gas phase, the reaction rate was directly proportional to both the partial pressure of the hexafluoride and moisture and the area of the solid surfaces available for reaction. Adsorbed hexafluoride and HF on the reaction surface reduced the reaction rate at partial pressures greater than 0.001 mm Hg. Reaction in the gas phase was detected at moisture partial pressures greater than 1.0 mm Hg and resulted in part in the solid reaction product being produced as fine particles, less than 0.1 micron in diameter, in the gas phase. (auth)

17628 HYDROGEN EXCHANGE OF AZULENES. VI. ACID-CATALYZED DEDEUTERATION OF AZULENE. Gruen, L. C.; Long, F. A. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 89: 1287-91(Mar. 15, 1967).

The general acid catalyzed dedeuteration of azulene-1-d was studied in dilute aqueous hydrochloric acid solution and also in aqueous formic acid–formate and acetic acid–acetate buffer solutions at 25°. A small positive ionic strength effect was observed on the second-order rate coefficient for hydrogen ion catalysis. For catalysis by both the strong and weak acids, the second-order rate coefficient ratio k^D/k^T for exchange is in the range 2.0 to 2.5. By assuming an A-SE2 mechanism for the reaction proceeding via a conjugate acid intermediate, and by combining the kinetic hydrogen isotope effect and solvent hydrogen isotope effect, it was possible to calculate isotope effects characteristic of individual steps in the exchange reaction. In particular, the kinetic hydrogen isotope ratio k_s^H/k_s^D, which gives the relative rate of loss of a proton and a deuteron from the protonated intermediate to a given base, was found to have the following values: 9.2 ± 0.8 for reaction with the base water; 6.3 ± 1.0 for reaction with formate ion; 6.1 ± 0.9 for reaction with acetate ion. These ratios are discussed in terms of current theory of isotope effects and the relative acidities of substrate and catalyst. (auth)

17629 KINETIC ISOTOPE EFFECTS UPON THE HYDROLYSIS OF PYRIDINE ARYLBORANES. Davis, Robert Earl; Kenson, Robert E. (Purdue Univ., Lafayette, Ind.). J. Amer. Chem. Soc., 89: 1384-9(Mar. 15, 1967).

The deuterium kinetic isotope effect for the hydrolysis of a series of pyridine arylboranes was measured. The results indicate that both a normal (>1) primary and an inverse (1<) secondary isotope effect are probably involved in the rate-determining process. A correlation was found between the boron–hydrogen stretching frequency of the arylborane and the kinetic isotope

effect on the hydrolysis of pyridine p-$XC_6H_4BH_2$. The k_H/k_D values and the stretching frequencies are p-Cl, $k_H/k_D = 0.924 \pm 0.002$, $\nu_{B-H} = 2353$; p-H, $k_H/k_D = 0.966 \pm 0.008$, $\nu_{B-H} = 2345$; p-CH_3, $k_H/k_D = 1.147 \pm 0.006$, $\nu_{B-H} = 2331$; p-CH_3O, $k_H/k_D = 1.406 \pm 0.022$, $\nu_{B-H} = 2326$ cm^{-1}. The value of k_H/k_D increases as the strength of the boron—hydrogen bond (or the stretching frequency) decreases. (auth)

17630 THE MECHANISM OF ^{19}F EXCHANGE IN THE TiF_4 2(DONOR) COMPLEXES. Dyer, Daniel S.; Ragsdale, Ronald O. (Univ. of Utah, Salt Lake City). J. Amer. Chem. Soc., 89: 1528-9(Mar. 15, 1967).

Temperature dependence in the ^{19}F NMR spectra of solutions of cis $TiF_4 \cdot 2$(donor) complexes, which was reported previously, is discussed. The proton NMR spectra of $TiF_4 \cdot 2$(N,N-diethylformamide) solutions were studied at ambient temperature as a function of the concentration of excess N,N-diethylformamide, and a mechanism proposed for the temperature-dependent exchange of fluorine nuclei. Results indicate that this exchange involves both inter- and intramolecular exchange processes, involving dissociation of a donor molecule followed by anharmonic vibration of a nonrigid intermediate formed by the dissociation. (J.G.B.)

17631 HYDROGEN EXCHANGE OF AZULENES. VII. MAGNITUDES OF THE KINETIC ISOTOPE EFFECTS. Longridge, J. L.; Long, F. A. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 89: 1292-7(Mar. 15, 1967).

The rates of proton transfer to and from guaiazulene, 4,6,8-trimethylazulene, and guaiazulene-2-sulfonate in dilute aqueous acid solutions (<0.5M) were measured using a continuous flow apparatus. Combining these data with pK values from equilibrium protonation studies permits calculation of k_f and k_r, the first-order rate coefficients for protonation and deprotonation. Data are also reported on detritiation studies of these molecules in dilute acid and buffer solutions. These measurements made it possible to calculate the ratio k_r^H/k_r^T, the relative rates of loss of a proton or a triton to a base from the protonated intermediate. The resulting kinetic isotope effects, expressed as k^H/k^D ratios, range from 6.0 to 9.6. These results, together with data for other aromatic carbon bases, support a recent suggestion that highest isotope effects are observed where the proton is being transferred between bases of similar strengths. (auth)

17632 SPECTROSCOPIC INVESTIGATIONS ON COMPOUNDS WITH A $CS^I_2S^{II}$ GROUPING. XII. INFRARED SPECTRA AND HMO CALCULATIONS ON $SC(SH_2)$ AND $SC(SD)_2$. Mueller, A.; Krebs, B.; Gattow, G. (Univ., Goettingen, Ger. Univ., Mainz). Z. Anorg. Allg. Chem., 349: 74-81(Jan. 1967). (In German).

The normal vibrations of molecules of the type $WX(YZ)_2$ were analyzed. The main absorption bands in the infrared spectrum of trithiocarbonic acid were assigned to the fundamental vibrations of the molecule. Using the Hückel MO method, π bond orders and π electron densities were calculated for $SC(SH)_2$. (auth)

17633 PLUTONIUM(III)–THIOCYANATE COMPLEXES. INVESTIGATIONS BY MEANS OF ELECTROPHORESIS AND ION EXCHANGE RESINS. Cassol, Alberto; Magon, Luciano (Univ., Padua). Ric. Sci., 36: 1194-7(Nov. 1966). (In Italian).

The system Pu(III)–thiocyanate in aqueous solution was investigated by paper electrophoresis, anion exchange paper chromatography and ion exchange resins. The formation of anionic complexes is discussed. (auth)

17634 NICKEL-CATALYSED HYDROGEN EXCHANGE OF ANILINE, PHENOL, AND THEIR ALKYLATED DERIVATIVES WITH DEUTERIUM OXIDE. Macdonald, C. G.; Shannon, J. S. (CSIRO, Chatswood, New South Wales). Austral. J. Chem., 20: 297-311(Feb. 1967).

Selective exchange of hydrogen atoms ortho to amino or hydroxyl groups, together with benzylic hydrogen atoms in aniline, phenol, and their C-alkylated derivatives, was achieved by allowing these compounds to react with deuterium oxide over nickel on kieselguhr at 99°. In addition to the benzylic hydrogen atoms, alkyl hydrogen atoms farther from the aromatic ring underwent slower exchange. Hydrogen atoms ortho to methoxyl did not exchange. Mechanisms of the catalytic exchange reactions are discussed in the light of the results of deuterium distribution measurements and poisoning experiments with electron donors. (auth)

17635 COMPLEX FORMATION OF THE $UO_2(NO_3)_2$–H_2O_2–EDTA–H_2O SYSTEM. Polozhenskaya, L. P.; Solntseva, L. F.; Gurevich, A. M. Radiokhimiya, 8: 658-64(1966). (In Russian).

Studies of the solid-phase $UO_2(NO_3)_2-H_2O_2-Na_2H_2Y-H_2O$ system (Y = EDTA ions) revealed the synthesis of mixed complex uranyl compounds: $[(UO_2)_2(OO)H_2Y] \cdot 4H_2O$, $Na_2[(UO_2)_2(OO)Y] \cdot 7H_2O$, $[(UO_2)_2(OO)_2(H_4Y)] \cdot 9H_2O$, and $[(UO_2)_2(OO)(H_4Y)] \cdot 10H_2O$. Thermogravimetric analysis indicated that the difficultly soluble complex compounds are formed at pH's identical to the formation of uranyl complexes with EDTA anions. EDTA was found in the inner spheres of the complexes not only as ions but also as non-dissociated molecules of the acid. (R.V.J.)

17636 KINETICS OF URANIUM TRIOXIDE. I. DISSOLUTION EQUATION FOR SPECIFIC SOLUTION RATE OF VARIOUSLY SHAPED BODIES. Kanevskii, E. A. Radiokhimiya, 8: 664-70 (1966). (In Russian).

An analysis was made of the basic equations for determining the rate of uranium trioxide dissolution. Equations were developed for the specific dissolution rate of free spherical, cubic, and cylindrical bodies and for attached cylindrically shaped tablets. (R.V.J.)

17637 PREPARATION OF AQUEOUS SOLUTIONS OF TRIVALENT URANIUM. Peretrukhin, V. F.; Krot, N. N.; Gel'man, A. D. Radiokhimiya, 8: 670-3(1966). (In Russian).

A method is suggested for producing aqueous solutions of trivalent uranium free from tetravalent uranium or other cation impurities. The method consists of electrolytic uranium reduction on a mercury cathode followed by selective extraction of tetravalent uranium by the di-2-ethylhexyl ester of phosphoric acid. The method produced up to 34 g/l concentration of trivalent uranium in chloride solution. (R.V.J.)

17638 THERMOCHEMISTRY OF BINARY SYSTEMS. II. THE TBP–SOLVATE SYSTEMS. Afanas'ev, Yu. A.; Nikolaev, A. V.; Korojeva, T. I.; Babina, K. A. Radiokhimiya, 8: 699-702 (1966). (In Russian).

The heat of TBP mixing with solvates consisting of uranyl, thorium, cerium(IV), and cerium(III) ions was determined. Mixing of the examined systems was irregular. All solvates except $Ce(NO_3)_3 \cdot 3TBP$ while dissolving in the TBP added two molecules of TBP per one molecule of the solvate at comparatively low heats of solvation. (R.V.J.)

17639 SOLUBILITY OF PLUTONIUM(IV) SULFATES IN SULFURIC ACID SOLUTIONS. Pozharskaya, M. E.; Nikol'skii, V. D.; Zastenker, E. E.; Bedina, O. L. Radiokhimiya, 8: 716-17(1966). (In Russian).

Solubility of plutonium(IV) sulfates at 25 and 50°C in sulfuric acid solutions was studied as a function of the concentration of sulfuric acid. The solubility curves are constructed for the two temperatures and the composition of donor phases for $Pu(SO_4)_2-H_2O-H_2SO_4$ at 25°C was determined. (R.V.J.)

17640 CLATHRATE COMPOUNDS OF π CRESOL WITH INERT GASES. II. COMPOUNDS OF π CRESOL WITH KRYPTON AND RADON. Trofimov, A. M.; Kazankin, Yu. N. Radiokhimiya, 8: 720-3(1966). (In Russian).

A p-cresol–krypton clathrate was prepared and the dissociation pressure at 5 to 35°C determined. The heat of formation of the compound from solid and liquid p-cresol was found to be 4800 and 21500 cal/mole, respectively. The results of physicochemical analysis described the composition by the formula $Kr \cdot 6C_7H_8O$ and, also, showed that radon is capable of forming clathrate compounds with p-cresol. Radon fractionation in isomorphic cocrystallization with xenon in clathrate compounds with p-cresol was determined at 20 and 30°C. (R.V.J.)

17641 HYDROGEN–DEUTERIUM EXCHANGE IN SOME HALOPYRIDINE N-OXIDES: RELATIVE POSITIONAL REACTIVITIES. Zoltewicz, John A.; Kauffman, Glenn M. (Univ. of Florida, Gainesville). Tetrahedron Lett., No. 4, 337-42(Jan. 1967).

Conditions used to induce base-catalyzed H-D exchange at several positions in 3,5-dichloropyridine-N-oxide (I) and in 3-chloropyridine-N-oxide (II) and the relative rates of deprotonation for positions within each of these substrates are reported. The NMR spectrum of pyridine I that was reacted with D_2O exhibited an A_2B spectrum with a doublet at 1.53 τ and a triplet at 2.21 τ in methanol (area ratio 2:1). Exchange occurred at 3 positions of I; >97 at. % D was introduced. To differentiate between the reactivity of 2,6-H and 4-H of I, a solution of 3,5-dichloropyridine N-oxide-d_3 was examined. The increase in the 2,6-H/4-H area ratio to 13/1 indicated exchange had occurred more rapidly at the 2,6-positions. Similar experiments were performed with II and again the site of hydrogen exchange was ascertained by NMR. After II was heated a product was isolated, having a spectrum (aqueous solution) consisting of a pair of AB doublets at 2.21 and 2.36 (J = 8.8 cps; area ratio 1:1) and very weak signals at lower field. These doublets are characteristic of 4-H and 5-H of II and this substance may be formulated as 3-chloropyridine N-oxide-2,6-d_2 (>95 at. % D). Exchange was more rapid at 2-H than at 6-H. It was established that the order of decreasing ease of hydrogen exchange in II is 2 > 6 > 4 > 5. The deprotonation rate for I at the 2,6-position was about 10-fold greater than at the 4-position. In II exchange at 2-H was ~100

times faster than at 6-H and deprotonation at 6-H was, in turn, about 100 times faster than at 4-H. It was concluded that an N-O grouping is more effective than a Cl atom in activating equivalent positions of an aromatic ring for H exchange. Two possible mechanisms to explain exchange are presented. (BBB)

17642 VALIDITY OF THE NERNST DISTRIBUTION LAW AT LOW CONCENTRATIONS. Bock, Rudolf; Monerjan, Alfred (Johannes Gutenberg-Univ., Mainz). Z. Anal. Chem., 226: 29-49(1967). (In German).

The distribution of inorganic substances between aqueous solutions and organic solvents follows in many cases the Nernst distribution law even at very low concentrations. Separations can be effected in these concentration ranges. There are many systems, however, with concentration-dependent distribution, so that the validity of Nernst's law has to be proved in every case. (auth)

17643 ISOTOPIC EFFECTS ON VAPOR PRESSURE. II. EFFECT OF DEUTERIUM SUBSTITUTION ON THE VAPOR PRESSURES OF METHANOL AND ETHANOL. Kiss, Istvan; Jakli, Gyoergy; Jancso, Gabor; Illy, H. (Central Research Inst. for Physics, Budapest). Acta Chim. Acad. Sci. Hung., 51: 65-78 (1967).

The difference between vapor pressures of CH_3OH and CH_3OD, and those of C_2H_5OH and C_2H_5OD were determined in a wide range of temperatures. The separation factor (α) for distillation of the isotopic mixtures was calculated. The temperature dependence of α can be given with good approximation by Bigeleisen's equation, $\ln \alpha = A/T^2 - B/T$, where A and B are constants in a definite range of temperature. The crossover temperatures above which the heavier molecule becomes more volatile, and the differences in the heats of vaporization, were also determined. (auth)

17644 CHLORINE ISOTOPIC EXCHANGE BETWEEN LITHIUM ^{36}Cl AND 2,4,6-TRINITROCHLOROBENZENE IN ETHANOLIC SOLUTION. Gore, P. H.; Morris, D. F. C.; Webb, T. J. (Brunel Univ., London). Radiochim. Acta, 6: 122-5(Dec. 1966).

The isotopic exchange reaction between 2,4,6-trinitrochlorobenzene and $Li^{36}Cl$ was investigated in an ethanol solution over a range of concentrations of reactants between 0.075 and 0.125 mole l^{-1}. The reaction is second order and specific rates and Arrhenius parameters were calculated. Some measurements were made on the corresponding exchange reactions of 2,4-dinitrochlorobenzene and o-nitrochlorobenzene. (auth)

17645 CRYSTAL STRUCTURE OF HYDROGEN ISOTOPES. Bostanjoglo, O.; Kleinschmidt, R. (Technical Univ., Berlin). J. Chem. Phys., 46: 2004-5(Mar. 1, 1967).

Annealing processes in layers of $\underline{N}$-H_2, HD, and $\underline{N}$-O_2 were investigated by electron diffraction at 2.8 to 4.5°K in search of a hexagonal phase. Results confirmed previous observations of an fcc structure. If the layers were heated to temperatures at which rapid sublimation set in, sharp reflections belonging to an hcp structure appeared, which persisted down to 2.8°K. (M.C.G.)

17646 DEUTERATION AND SOLVENT COMPOSITION EFFECTS IN THE HELIX-COIL TRANSITION OF POLY-γ-BENZYL-L-GLUTAMATE. Karasz, F. E.; O'Reilly, J. M. (General Electric Research and Development Center, Schenectady, N. Y.). Biopolymers, 4: 1015-23(1966).

The effects of deuteration and of changes in solvent composition on the thermodynamics of the helix-coil transition were studied by calorimetric and optical measurements in the poly-γ-benzyl-L-glutamate–dichloroacetic acid–1,2-dichloroethane system. For a given solvent composition, deuteration of the polypeptide and of the acid lowered the transition temperature T_c, while an increase in the volume fraction of acid in the solvent raised T_c. A rise was accompanied by a decrease in both the van't Hoff and the calorimetric heats of transition, but at different rates. The result was a temperature dependence of the Zimm–Bragg cooperation parameter σ. Possible causes of this result and its implications are discussed. The results for σ indicate that deuteration in itself does not affect σ (or ΔH and ΔH_0) when the data are corrected for changes in T_c. (TSS)

17647 INFRARED ABSORPTION SPECTRUM OF KERATIN. II. DEUTERATION STUDIES. Bendit, E. G. (CSIRO, Sydney). Biopolymers, 4: 561-77(1966).

New bands were found in the spectra of deuterated α- and β-keratin. The deuteration difference spectrum was used for the determination of frequencies of previously unsuspected bands. Thus it is found that the amide A and II frequencies of the nonhelical component in α-keratin occur at 3310-3320 and 1520 cm^{-1}, respectively, and that both bands exhibit dichroism consistent with polypeptide chains, which have a measure of alignment parallel to the fiber axis. The parallel dichroism of the amide II′ band of this phase at about 1435 cm^{-1} also indicates some alignment. A nondichroic residual band at 1513 cm^{-1} in highly deuterated α-keratin is assigned to the tyrosine residue as a sharp band near this frequency is found in the spectrum of polytyrosine. The $\nu\|(o)$ component of the α-helix is weak or absent in α-keratin, and the relatively sharp band observed near this frequency is thought to be due to the tyrosine residue, while its dichroism is caused by the presence of dichroic nonhelical material. A band near 1575 cm^{-1} in deuterated α- and β-keratin is tentatively assigned to the deuterated guanidinium group of arginine. This band becomes progressively more prominent during deuteration, which indicates that some arginine side chains are slow to exchange, possibly because their environment prevents interaction with D_2O. The deuteration difference spectrum also shows that, contrary to earlier views, helical material in α-keratin exchanges significantly during the early stages of deuteration, although at a slower rate than the nonhelical material, while part of the nonhelical phase does not exchange as rapidly as had been thought and makes a contribution even after many hours or days. (BBB)

17648 INVESTIGATION OF STRUCTURE IN PARA- AND ORTHO-LIQUID DEUTERIUM BY NEUTRON SCATTERING. Talhouk, Sami Jamil. Columbus, Ohio, Ohio State Univ., 1966. 146p.

Thesis.

The structures of two liquid deuterium samples, of different ortho- para compositions and under their saturation vapor pressure, were studied by diffraction of neutrons (λ = 1.00 Å) at 20.4°K. The first sample, referred to as the converted sample, consisted of 3.1% para-D_2 (J = 1) and 96.9% ortho (J = 0). The second sample consisted of 85.0% para- and 15.0% ortho-D_2 and is referred to as the enriched sample (enriched in J = 1). At low scattering angles the converted sample scattered more strongly than the enriched one. The major peaks for the converted and enriched samples occurred at 19.25 and 19.75°, respectively. Three treatments, corresponding to three models, were used to determine the radial distributions (using modified Zernike–Prins type formulas). All three treatments show that for the enriched D_2, the maxima in the radial distribution function are located at shorter distances from the reference scatterer and have better resolution than the corresponding maxima of the converted D_2. Further, both the molar volume (calculated on the basis of partial close packing) and the isothermal compressibility are smaller for the enriched sample. These results indicate that there is higher degree of order in the enriched sample, and therefore higher degree of order in the para (J = 1) species of deuterium. (TSS)

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Refer also to abstracts 17721, 18819, and 19190.

17649 (AECL-2655) THE RADIOLYSIS OF ORTHO- AND META-TERPHENYL. III. WITH A MIXTURE OF FAST NEUTRONS AND GAMMA RAYS AT A DOSE RATE OF 1 W g^{-1}. Boyd, A. W.; Connor, H. W. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Nov. 1966. 8p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $0.50.

Samples of ortho- and meta-terphenyl have been irradiated at temperatures from 110 to 450°C in an annular uranium rod in a lattice position in NRX. The total energy deposition rate in the samples, consisting of equal contributions from fast neutrons and γ rays, was 1 W g^{-1}. Over this temperature range the G-values for the disappearance of ortho-terphenyl increased from 0.4 to 1.5 instead of ~4 as observed at 0.1–0.3 W g^{-1}. G-values for meta-terphenyl disappearance at 1 W g^{-1} from 225 to 420° increased from 0.47 to 0.56 instead of 0.9 at the lower dose rates. G-values for high boiler formation at 1 W g^{-1} showed even less temperature dependence than disappearance G-values. A mechanism to explain these results is proposed. (auth)

17650 (NP-16560) INHIBITION DE LA CORROSION RADIOLYTIQUE DU GRAPHITE PAR LE GAZ CARBONIQUE. Iere PARTIE. ETUDE DE LA REACTION RADIOLYTIQUE METHANE-GAZ CARBONIQUE EN PRESENCE DE GRAPHITE. (Inhibition of Radiolytic Corrosion of Graphite by Carbon Dioxide. Part I. Study of the Methane–Carbon Dioxide Radiolytic Reaction in Presence of Graphite). Arragon, P.; Pointud, M. L.; Seguin, M.; Tanis, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Nov. 2, 1965. 54p. (In French). Dep. mn.

Methane was studied as an inhibiting agent of the radiolytic corrosion of graphite by carbon dioxide. The experimental apparatus was constituted of two BUR loops operating in closed circuits under 40 bars and at temperatures between 200 and 550°C. The graphite samples were weighed before and after irradiation. The concentrations of the different gases present in the loop were determined by gaseous phase chromatography. The weight losses of the graphite were always very strongly decreased with respect

to those existing in the presence of pure carbon dioxide. Carbon deposition caused an increase in the weight of the samples when the methane concentrations were high. Gas analyses indicated that the concentrations of carbon monoxide, H_2, and water vapor in the steady state depend on the methane concentration, circulation rate of the gases, γ flux, and temperature. (tr-auth)

17651 (NYO-3329-6) RADIATION SYNTHESIS OF ARTIFICIAL KIDNEY MEMBRANES. Final Report. (Columbia Univ., New York. Dept. of Chemical Engineering). Oct. 15, 1966. Contract AT(30-1)-3329. 20p. DTIE.

The synthesis of artificial kidney membranes by radiation crosslinking of polyvinyl alcohol (PVA) and polyvinyl pyrrolidone (PVP) is reported. The two polymers were crosslinked very efficiently by the use of small amounts of allyl methacrylate in conjunction with the radiation. The PVP crosslinked membranes were not particularly useful as artificial kidney membranes. They were too weak physically to even allow the testing of permeability properties. The PVA membranes could be tested in the dialyzer and possessed good permeability characteristics. However, their strength was low and efforts to date to improve this property have been unsuccessful. It was concluded, though, that the radiation plus polyfunctional monomer technique offers a very efficient way of crosslinking polymers. (auth)

17652 (ORO-3303-2) ELECTRON SPIN RESONANCE AND OPTICAL ABSORPTION IN COMPACTED VITREOUS SILICA. Final Report. Keiffer, D[avid G.] (Loyola Univ., New Orleans, La.). Dec. 15, 1966. Contract AT(40-1)-3303. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Color centers are produced very efficiently in compacted vitreous silica when irradiated by gamma rays. The rate of production was measured by electron spin resonance and the optical absorption of these centers was investigated in silica compacted at room temperature and at 500°C. The paramagnetic centers are identified as E′ centers, which occur in irradiated uncompacted silica. There is, in addition to the E′ optical absorption band, a new band at 260 mμ. The possibility that the production of E′ centers is responsible for the rapid density changes that occur in irradiated compacted silica is discussed. (auth)

17653 PAIRWISE TRAPPING IN SOLID STATE PHOTOELIMINATIONS. Symons, M. C. R. (Univ. of Leicester, Eng.). Nature, 213: 1226(Mar. 25, 1967).

In certain circumstances radicals may be trapped in pairs separated so well that there is no chemical bond between them, but sufficiently close that there is magnetic coupling between the unpaired electrons. If the trapping is sufficiently precise this may be revealed in the ESR spectrum, which will be characteristic of a triplet state species. Photolysis or radiolysis sometimes involves the elimination of small stable molecules such as nitrogen or carbon monoxide, and if this occurs in a rigid medium the resulting radicals would appear to be ideally placed for the production of such weakly coupled systems, with the precision required for detection. Gamma irradiation of crystalline diaryl carbonates, involving formation of CO, gives pairs of aryloxy radicals separated "magnetically" by about 6 Å. A study of the solid state uv photolysis of azobisisobutyronitrile is reported, which results in a species with an ESR spectrum that is also characteristic of a triplet, and has exactly the form required for radical pairs. The "magnetic" separation of 5.8 Å between the radicals is very close to expectation if the two $(CH_3)_2-C-CN$ radicals simply become planar on "extrusion" of a nitrogen molecule. The results obtained are of considerable importance in that they prove that nitrogen is either "extruded" in a one-step process or, less reasonably, that the radical $N_2C(CH_3)_2CN$ loses nitrogen spontaneously even at 77°K. (UK)

17654 STRUCTURE OF FREE RADICALS IN IRRADIATED MONOCRYSTALS OF 3,3-PENTAMETHYLENEGLUTARIC ACID. Falaleev, O. V.; Tsvetkov, Yu. D. (Inst. of Chemical Kinetics and Combustion, Novosibirsk, USSR). Zh. Strukt. Khim., 8: 37-42(Jan.-Feb. 1967). (In Russian).

The EPR method was used for studying the structure of free radicals stable at room temperature in irradiated 3,3-pentamethyleneglutaric acid (1,1-cyclopentanedicarboxylic acid) monocrystals. The non-evaporated electron in a free radical is localized in the p-orbit of carbon atom next to the carboxyl group and it interacts with one α proton. Orientation of $C-H_\alpha$ fragment in the crystal was found and constant values describing the superfine interactions were obtained. (tr-auth)

17655 POLYMERIZATION OF ADSORBED HYDROCARBONS BY ELECTRON BOMBARDMENT. Kunze, D.; Peters, O.; Sauerbrey, G. (Technische Univ., Berlin). Z. Angew. Phys., 22: 69-75(1967). (In German).

The growth velocity of polymerization layers on electron-bombarded metal surfaces due to the presence of organic gases (several vacuum pump fluids, benzene) was measured as a function of electron current density, electron energy, and thickness of the polymer layer. The growth velocities of all investigated layers had a maximum value between 200 and 300 eV. On freshly evaporated nickel surfaces the growth velocity was very small; the saturation values were reached when the polymer layer was 50 Å thick. Secondary electron emission and polymerization velocity were compared in their dependence on electron energy and thickness of the polymer layer. (auth)

17656 SOME REMARKS ON RADIATION STABILITY OF LOW MELTING COOLANTS IN LIQUID AND SOLID STATE. Khramchenkov, V. A.; Chkheidze, I. I.; Aleksenko, Yu. N.; Buben, N. Ya. At. Energ (USSR), 22: 27-30(Jan. 1967). (In Russian).

The yield of radicals G_r in oils, hydroterphenyls, and monoisopropylbiphenyls during irradiation with electrons at –170°C and also the yield of high-boiling products G_{hb} during the irradiation of these products in reactors at temperatures of 50°C were measured. From a comparison of the magnitudes it was determined that with a high value of G_r there is a corresponding high value of G_{hb}. It was shown that the calculated radiation radical yield in the liquid phase surpasses the values measured in the solid phase no more than four times. On the basis of this it was concluded that the radiation stability of organic coolants in the liquid phase can be predicted from the radiation yield of radicals in the solid phase. (tr-auth)

17657 ELECTRON SPIN RESONANCE STUDIES OF NEUTRON-IRRADIATED DPPH. Van Itterbeek, A.; Witters, J.; Van Audekercke, R.; Subramanian S.; Nihoul, J. (Instituut voor Lage Temperaturen en Technische Fysica, Leuven, Belg.). Physica, 32: 2115-22(Nov.-Dec. 1966).

The damages induced in solid crystalline $\alpha-\alpha$ diphenyl β-picryl hydrazyl (DPPH), when neutron irradiated at liquid-nitrogen temperature, were studied using the technique of paramagnetic resonance. A model is proposed which explains satisfactorily the observed variation in g-value, linewidth, and spin concentration. (auth)

17658 AMORPHOUS POLYAMIDE FROM TEREPHTHALIC ACID AND BRANCHED DIAMINES. Gabler, R.; Mueller, H.; Ashby, G. E.; Agouri, E. R.; Meyer, H.-R.; Kabas, G. (Forschungslaboratorium W. R. Grace Research, Zurich). Chimia (Aarau), 21: 65-81(Feb. 15, 1967). (In German).

A group of terephthalic polyamides based on highly branched hexamethylene diamines is described. The compounds obtained are discussed in terms of structural isomerism and their polycondensation with terephthalic acid was performed according to interfacial and block condensation methods. The condensation product of terephthalic acid with trimethyl hexamethylene diamine, was proven to be permanently amorphous through differential thermal analysis and x-ray investigation. Numerous data on physical and chemical properties are given for this special polyamide and characteristic differences relative to commercial polyamides are unveiled. The development of color centers in the solid polymer under shear deformation or γ exposure is discussed in terms of trapped radical formation. (auth)

17659 ANNEALING IN GAMMA-IRRADIATED CALCIUM BROMATE. Khare, M.; Mohanty, S. R. (Banaras Hindu Univ., Banaras, India). J. Inorg. Nucl. Chem., 853-5(Mar. 1967).

The effects of lattice rearrangement accompanying loss or regain of water of crystallization on the annealing of chemical radiation damage in calcium bromate monohydrate–anhydrous system. The system was irradiated with ^{60}Co γ rays to a dose of 50 Mrad/hr. Isothermal annealing runs were made at various temperatures in the range 100 to 160°C. Results on the monohydrate showed the usual annealing characteristic at 100°C at which the water of crystallization continued intact. At 120°C and above, however, lattice mobility occasioned by the loss of crystal water brought about a rapid initial recovery of the damage following which there was only a small recovery even on long heating. Uptake of water of crystallization by irradiated anhydrous calcium bromate at room temperature to form the monohydrate resulted in considerable recovery of the damage, but subsequent thermal annealing behavior of the material at temperatures below the dehydration temperature was quite normal although the extent of annealing was smaller than that for the irradiated hydrate. (P.C.H.)

17660 THE INFLUENCE OF γ RADIATION ON THE ELECTRICAL PROPERTIES OF TRIGLYCINSULPHATE IN A TEMPERATURE AUTOSTABILIZATION REGIME. Lescinsky, M. (Inst. of Radio Engineering and Electronics, Prague); Kohout, J.; Janko, L. Czech. J. Phys., B17: 264-73(1967).

The influence of ^{60}Co γ radiation on some of the electric properties of single crystals of triglycine sulfate irradiated under various conditions was studied with special emphasis on the temperature autostabilization regime. The smallest changes in these

properties occurred with crystals whose temperature during irradiation was kept above the Curie temperature and which were at the same time exposed to the effects of a strong alternating electric field, and with crystals kept in the temperature autostabilization regime during irradiation. The changes caused by irradiation can be partly eliminated by additionally bringing the crystals into the autostabilization regime (renovation). (auth)

17661 ENDOR STUDY OF IRRADIATED HISTIDINE HCl. Box, Harold C.; Freund, Harold G.; Lilga, Kenneth T. (Roswell Park Memorial Inst., Buffalo, N. Y.). Contract AT(30-1)-3558. J. Chem. Phys., 46: 2130-3(Mar. 15, 1967). (NYO-3558-7).

Free-radical formation was studied in x-irradiated single crystals of histidine HCl using conventional electron spin resonance (ESR) as well as double-resonance (ENDOR) spectroscopy. The spectra are attributed to a free radical formed by the addition of hydrogen to the C_2 position on the imidazole ring of histidine. (auth)

17662 EFFECT OF COMPLEXING AGENTS ON POLYMERIZATION OF ALLYL MONOMERS. Kulikova, V. F.; Savinova, I. V.; Zubov, V. P.; Kabanov, V. A.; Polak, L. S.; Kargin, V. A. (Moscow State Univ. Inst. Petroleum Chemical Synthesis, Academy of Sciences, USSR). Vysokomol. Soedin., 9: 299-302(Feb. 1967). (In Russian).

The rate of polymerization of allylacetate (AAc) and allyl alcohol (AA) initiated by γ-irradiation or photochemically, increased in presence of $ZnCl_2$. In coming from pure monomer to a 1:1 complex in case of AAc or to a complex of AA with $ZnCl_2$ of 2:1 composition, the rate of polymerization increased by 5.5 to 6 times and 22 times, correspondingly. The product of AAc polymerization was a branched polymer of high molecular mass. The rate of initiation in the AAc–$ZnCl_2$ system was determined and the ir-spectrum of the AAc–$ZnCl_2$ complex was studied. On the basis of the results obtained it was proposed that the role of the complexing agent in the increase of the polymerization rate may consist of activation of allyl radicals of chain transfer and formation of mobile organized array of monomer molecules. (auth)

17663 ELECTRON SPIN RESONANCE OF AN IRRADIATED SINGLE CRYSTAL OF AMMONIUM TRIFLUOROACETATE. Srygley, Fletcher D.; Gordy, W. (Duke Univ., Durham, N. C.). J. Chem. Phys., 46: 2245-52(Mar. 15, 1967).

The electron spin resonance of γ-irradiated single crystals of ammonium trifluoroacetate (CF_3COONH_4) was investigated at 300 and at 77°K. Free radicals of two types were detected at 300°K. One of these proved to be CF_2COONH_4 and the other was tentatively identified as CF_3CO_2. The nuclear couplings of the two F's of the former are equivalent and axially symmetric with $A_{||}$ = 188 G and $A_{\perp}$ = 14 G. These couplings indicate spin densities of 0.12 in a 2p orbital of each F. No hyperfine structure is observed for the CF_3CO_2. This is interpreted to mean that the spin density is concentrated on the oxygens. At 77°K the negatively charged radical $(CF_3COONH_4)^-$ was found. Its spectrum was observed to change into that for CF_2COONH_4 as the temperature was raised. Different coupling tensors were observed for each of its three F's. The principal elements of the couplings indicated 2p spin densities of 0.11, 0.13, and 0.13 on the three F's. (auth)

17664 RADIATION-INDUCED CATALYTIC POLYMERIZATION. I. THEORY. Temkin, A. Ya. (Topchiev Inst. of Petrochemical Synthesis, Moscow). J. Polym. Sci., Pt. A-2, 5: 211-23(Jan. 1967).

The kinetics of radiation polymerization on a solid catalyst is discussed, under the condition that only linear termination of the chain takes place. All the kinetic equations are balance equations of particles of each type adsorbed by unit mass of the catalyst, and this makes it possible to account for the effect on the kinetics of the time dependence of the magnitude of the part of its surface on which the reactions considered may take place. Integro-differential equations are used for calculating the molecular-weight distribution of the resulting polymer; this ensures higher accuracy of the formulas obtained than when differential equations are used and makes it possible to eliminate a number of limitations generally involved in the transition to differential equations. An expression was found for the molecular-weight distribution of the polymer product, which allows for the possibility of radioinduced catalytic polymerization on the resulting adsorbed polymer. Expressions were derived for the average molecular weight and yield (weight and molecular) of the polymer formed. Asymptotic formulas were obtained (for large irradiation times) for all the above values. The conclusions that can be drawn concerning the mechanism of the process based on a comparison of the formulas obtained with kinetic curves plotted from experimental data are given. It is shown how such a comparison can be utilized for calculating the rate constants for polymerization and chain termination reactions. (auth)

17665 INVESTIGATIONS IN THE FIELD OF RADIATION-INDUCED SOLID STATE POLYMERIZATION. XIX. SOLID STATE POLYMERIZATION OF TWO-COMPONENT SYSTEMS. Hardy, Gyula; Varga, Jozsef; Nagy, Gabor; Varga, Eszter; Sara, Laszlo. Magyar Kem. Foly., 73: 43-7(Jan. 1967). (In Hungarian).

The influence of benzoquinone was investigated in the solid-state polymerization of acrylamide, trioxane, and 3,3′-bis-chloromethyloxetane. The solid-state polymerization of trioxane in the presence of succinimide and naphthalene was studied. These two-component systems were characterized by the formation of simple eutectics. A comparison of the effect of benzoquinone and inert added compounds showed that the solid-state polymerization of acrylamide had radical mechanism; in the case of trioxane and 3,3′-bis-chloromethyloxetane the mechanism of the polymerization cannot be decided by the use of benzoquinone. Investigation of the system trioxane–naphthalene called attention to the important role of the conditions of crystallization in the polymerization to two-component systems. (auth)

17666 THE DETECTION OF TRAPPED ELECTRONS IN γ-IRRADIATED 3-METHYLPENTANE GLASSES BY ELECTRON SPIN RESONANCE. Tsuji, Kozo; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Contract AT(40-1)-2968. J. Amer. Chem. Soc., 89: 1526-8(Mar. 15, 1967). (ORO-2968-23).

The ESR spectra of γ-irradiated 3-methylpentane glass (3-MP) containing 0 to 20 mole % trimethylamine(TMA) were studied. Results indicated that the narrow resonance observed in the TMA-3-MP system was not due to the CO_2^- radical, but to a trapped electron. A maximum concentration of trapped electrons was found in the region of 10 mole % TMA. (J.G.B.)

17667 PRODUCTION OF SHORT-LIVED RADIOISOTOPES. Eugenio, Manuel R.; Davila, Aida T. (Philippine Atomic Research Center, Diliman, Quezon City). Philippines Nucl. J., 1: No. 1, 17-21(July 1966).

A description of the Philippine Research Reactor facilities for irradiation and isotope production is given and processing methods adapted for some important short-lived radioisotopes currently being produced in the Center are described. The preparation of sealed sources is discussed. (auth)

17668 RADIOCHEMICAL PURIFICATION OF THE ^{55}Fe ISOTOPE. Danilin, L. D.; Druzhinin, A. A.; Pavlova-Verevkina, I. Radiokhimiya, 8: 712-14(1966). (In Russian).

Radiochemical purification was undertaken with ^{55}Fe prepared from an iron foil enriched up to 94.4 wt % in ^{54}Fe and irradiated in a reactor by thermal neutrons with integral intensities of 10^{21} neutrons/cm^2. Separated radioactive iron, such as ^{55}Fe, contained a small amount of ^{59}Fe isotopes with 1100 and 1290 keV γ energies, whose activity did not exceed 10^{-4}% of the ^{55}Fe activity. Scintillation γ spectrometry with an NaI(Tl) crystal did not detect any ^{54}Mn and ^{60}Co impurities. (R.V.J.)

17669 CHEMICAL REACTION OF THE ^{14}C PRIMARY RECOIL ATOMS AND OF SECONDARY HIGH-ENERGY ATOMS OF THE ^{12}C SHIFT IN SOLID AMINO ACIDS. Firsova, L. P.; Videnkheft, A. Radiokhimiya, 8: 682-90(1966). (In Russian).

Radiochemical yields of a series of ^{14}C-labeled products produced by irradiation of the amino acids, norvaline and valine, were studied. The specific activity of parent compounds and glycol formed during stabilization of ^{14}C recoil atoms in the norvaline and valine was determined. (R.V.J.)

17670 HIGH-PRESSURE REACTIONS. III. HYDROLYSIS OF POLYACRYLONITRILE. Prince, M.; Hornyak, J. (New York Univ.). J. Polym. Sci., Pt. A-1, 5: 161-9(Jan. 1967).

Polyacrylonitrile prepared from γ-irradiated monomer reacts readily with water over a pressure range of 5,130 to 34,200 atm to yield polyacrylamide, while polymer prepared by conventional free-radical catalysts did not hydrolyze under the same conditions. Reaction rates at 85°C were measured; hydrolysis was extremely rapid at higher temperatures. Results indicated the radical nature of the reaction. Addition of a free-radical source increased the amount of hydrolysis. Pressure had an effect on the properties of the resulting polyacrylamide. (auth)

17671 COPOLYMERIZATION OF TRIOXANE BY γ-RADIATION. Roesinger, S.; Hermann, H.; Weissermel, K. (Farbwerke Hoechst AG, Frankdurt am Main). J. Polym. Sci., Pt. A-1, 5: 183-92(Jan. 1967). (In German).

High-molecular copolymers of trioxane with different cyclic ethers and formals were produced by γ radiation from a ^{60}Co source. It polymerized in the solid state at 53°C. Polymerization did not occur in the melt. Irradiation was carried out with exclusion of air at a dose rate of 7×10^3 RAD/hr. The polymerization rate increased considerably in the presence of 1,3-dioxolane and epichlorohydrin; the addition of other comonomers may reduce

the yield. The concentration of the comonomer was generally higher in the polymer than in the initial mix. These comonomers, which increase the polymerization rate, are introduced preferentially into the polymer chain; this is proved by the unstable polymer part and the thermal stability. Experiments with the trioxane–1,3-dioxolane system revealed that the unstable polymer part is markedly reduced and the heat stability considerably improved with rising concentrations of this monomer. The thermal stability and the reduced viscosity of these copolymers were within the range of technical processability. (auth)

17672 CHEMICAL TRANSFORMATIONS ACCOMPANYING THE IRRADIATION OF SOLID COMPOUNDS OF XENON IN A NEUTRON FLUX. Margraff, R.; Adloff, J. P. (CEN, Strasbourg). Radiochim. Acta, 6: 138-43(Dec. 1966). (In French).

Irradiation of xenon led to several radioisotopes allowing investigation of chemical effects of (n,γ) reactions, isomeric transition, and electron capture. Solid samples of XeF_2, XeF_4, and $Ba_2XeO_6 \cdot 2H_2O$ were irradiated in a neutron flux. Retention of radioxenon amounted to 93% in the difluoride; total retention approached 100% in the tetrafluoride, but two-thirds of the radioxenon appeared as XeF_2. No isotope effect was found. In perxenate, 30% of xenon remained chemically bound. The isomeric transition $^{133m}Xe \rightarrow {}^{133}Xe$ in XeF_4 did not lead to significant release of xenon. In the same matrix, ^{125}I daughter product of ^{125}Xe, appeared mainly as IF_5. (auth)

17673 BOND RUPTURE AND CHEMICAL SECONDARY REACTIONS IN DIPHENYLTELLURIUM BY THE (n,γ) PROCESS AND ISOMERIC TRANSITIONS. Riedel, H. J.; Merz, E. (Kernforschungsanlage, Juelich, Ger.). Radiochim. Acta, 6: 144-6 (Dec. 1966). (In German).

Chemical effects created by the isomeric transition of ^{129m}Te to the ground state were investigated on the organometallic compound $^{129}Te(C_6H_5)_2$. The results were compared with ones from the (n,γ) reaction on $Te(C_6H_5)_2$. Separation of the new Te compounds formed as a consequence of the nuclear process was achieved by adsorption chromatography on Al_2O_3. In many, but not in all cases, the nuclear transformation caused bond rupture. Practically identical labeled Te compounds were observed for both the isomeric transition and the (n,γ) process. The percentage yield distribution however showed certain characteristic deviations. A reaction mechanism, which may explain these observations, is discussed. It was concluded that the charge developed by the Auger process following internal conversion causes coulombic repulsion and gives a tellurium recoil atom, which, loosing its kinetic energy by collisions with neighboring molecules, creates a reaction zone of excited molecules, radicals and ions, and the reactivity is mainly influenced by it. (auth)

17674 A COMPARISON OF CHEMICAL EFFECTS OF (n,2n) AND (n,γ) ACTIVATION IN BROMOETHANE. Cole, A. J.; Mia, M. D.; Miller, G. E.; Shaw, P. F. D. (Oxford Univ.). Radiochim. Acta, 6: 150-62(Dec. 1966).

Gas-chromatographic analyses were made of compounds containing ^{80m}Br formed by (n,2n) or (n,γ) activation in bromoethane-bromine mixtures. Atoms of greater initial recoil energy show enhanced diffusive yields of all fractions; this was consistent with a more extensive distribution of radicals formed during thermalization. Scavenger insensitive yields were also greater, except for bromoethane, whose yield was decreased. The similarity of the product distribution indicated that atoms are activated by recoil rather than by charge effects; the relative diffusive yields of the different fractions were consistent with the formation of a hot-spike in which a greater proportion of the more reactive radicals is removed by reaction with the parent compound. Reactions leading to the formation of polybromocompounds are discussed, and it was tentatively concluded that the final distribution of products is determined by high-temperature chemical reactions rather than by hot-atom reactions. (auth)

17675 PRODUCTION OF ^{64}Cu IN HIGH SPECIFIC ACTIVITY BY THE SZILARD–CHALMERS PROCESS WITH COPPER PHTHALOCYANINE. Ebihara, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 6: 120-2(Dec. 1966).

A method for preparation of ^{64}Cu of high specific activity, superior to the solid-liquid extraction method in yield, enrichment factor, and operation time, is presented. About 40 mCi of ^{64}Cu with a specific activity as high as about 1000 mCi/mg Cu were obtained from 200 mg of α-copper phthalocyanine by irradiation in the JRR-2 reactor for 5 hours. (auth)

17676 THE ELECTRON PARAMAGNETIC RESONANCE (EPR) SPECTRA OF FREE RADICALS IN IRRADIATED, FROZEN FORMIC ACID. Khodzhaev, O. F.; Ershov, B. G.; Pikaev, A. K.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 169: 1379-82(Aug. 21, 1966). (In Russian).

Purified frozen samples of HCOOH, HCOOD, DCOOH, and DCOOD were given a ^{60}Co gamma dose of $3 \times 4 \times 10^{19}$ eV/ml at a temperature of –196°C, and EPR spectra were taken at –110 to –120°C. Two radicals were formed in general. The structure of the EPR spectrum of one of the radicals (radicals I and I') was determined by splitting of the unpaired electron spin on the hydrogen atom of a CH-group, and the structure of the other type of radical (radicals II and II') was determined by splitting of the unpaired electron spin on the hydrogen atom of a hydroxyl group. The radicals HCO and DCO were also present. The mechanism for the radiolysis of formic acid and the nature of the resulting radicals were determined by the existence of HCOOH in the form of a dimer. In the first stage the dimer decomposes to give a positively charged radical and an electron: $(HCOOH)_2 \rightarrow HCOOH)_2^+ + e^-$. The positive ion $(HCOOH)_2^+$ probably decomposes as follows: $(HCOOH)_2^+ \rightarrow H^+ + CO_2 + HC(OH)_2$. The G value for radicals (radicals/100 eV) is 3.0, and the G value for H_2 (molecules/100 eV) is 0.3. (TTT)

17677 IONIZATION OF LIQUIDS BY RADIATION. III. FIELD DEPENDENCE OF THE CONDUCTIVITY. Hummel, Andries; Allen, A. O. (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. J. Chem. Phys., 46: 1602-6(Mar. 1, 1967). (BNL–10402).

The conductivity of hexane under 1500-kV x rays was studied at fields up to 40 kV/cm. Conditions were attained under which the theoretical proportionality to dose rate and to plate separation was strictly obeyed. Data are also reported for diethyl ether and 1,4-dioxane, and for hexane irradiated by 2.4-KeV electrons from ^{37}Ar. Onsager's formula for probability of escape of a single ion pair describes the behavior of the conductivity of low-dielectric-constant liquids under high-energy x rays, but fails when applied to the results from 2.4-keV electrons, where an appreciable probability exists of escape of more than one ion pair from a group. (auth)

17678 CONFORMATION AND REACTION OF STEREOISOMERIC RADICALS TRAPPED IN IRRADIATED cis- AND trans-CYCLOHEXANE-1,2-diol. Ohmae, Tadayuki (Osaka Univ.); Sakurai, Hiroshi; Ohnishi, Shun-ichi; Kuwata, Keiji; Nitta, Isamu. J. Chem. Phys., 46: 1865-9(Mar. 1, 1967).

ERS measurements were carried out on samples of electron-irradiated cyclohexanediols. In the case of 1,2-diols, the results were consistent with an interpretation of trapping of two conformationally isomeric radicals, cis- and trans-cyclohexane-1,2-diol-1, at –196° C and their intramolecular conversion to cyclohexanone-2 or 2-hydroxycyclohexanone-6 radicals on warming to room temperature. (auth)

17679 THE INFLUENCE OF IONIZING RADIATION ON FATS. VI. POLYMERIZATION. Lueck, H.; Kohn, R.; Bach, H. (Deutsche Forschungsanstalt fuer Lebensmittelchemie, Munich). Fette Seifen Anstrichmittel, 66: 1063-71(Dec. 1964). (In German).

In the polymerization of fats by 100-MRAD doses of either 1 MeV electrons or γ rays (^{60}Co source) below 45°C, in vacuum, the increase in viscosity for iodine value above 30 was independent of the double bond content. Such oils include linseed oil, Chinese wood oil, soya oil, sunflower oil, corn oil, peanut oil, olive oil, lard, beef suet, and the insoluble (in acetone) part of beef suet at 0°C. Other oils studied, with lower I values, were acetone-insoluble fractions of beef suet at higher temperatures, hydrated coconut fat, and trilaurin. Variations in the composition of fats under irradiation were studied, as well as general properties of irradiated oils, to include polymer fractions, peroxide content, viscosity, molecular weight by freezing point, dielectric constant, and dielectric loss factor. Changes in the ir and uv spectra of typical oils on irradiation are illustrated. Mechanisms for polymerization are discussed. (BBB)

17680 EFFECT OF ADDITIVES ON THE RADIATION-INDUCED POLYMERIZATION OF TRIOXANE. Naruse, Tsutomu; Haga, Mikio (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 527-30(Mar. 1966). (In Japanese).

Effects of electron or proton acceptors, as additives on an ionic polymerization process considered to take part in the radio-induced solid-state polymerization of trioxane, were investigated. The rate of polymerization increased in the presence of electron acceptors and decreased markedly in the presence of proton acceptors. These results indicated the participation of a cationic mechanism. The free ion yield (G_{fi}) in trioxane was estimated to be about 1.3 by applying the Mayo-Overberger relation to results obtained in the presence of ammonia. (NSA of Japan)

17681 RADIATION-INDUCED COPOLYMERIZATION OF ALLYLALCOHOL AND SULFUR DIOXIDE. Ito, Masayuki; Kuri, Zenichiro (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 531-5(Mar. 1966). (In Japanese).

Mixtures of allyl alcohol and sulfur dioxide were irradiated with γ rays at various temperatures between −78 and −196°C. The ratio of allyl alcohol to sulfur dioxide in copolymers produced by γ-irradiation was found to be close to unity, independent of temperature and the concentration of allyl alcohol. The polymerization rate in liquid phase is proportional to the square root of dose rate and the addition of DPPH inhibits copolymer formation. In solid phase polymerization, the conversion limit was observed and post polymerization takes place in this phase. The polymerization yield is decreased by irradiation of light after γ irradiation at −196°C. (NSA of Japan)

17682 RADIATION-INDUCED COPOLYMERIZATION OF PROPYLENE AND SULFUR DIOXIDE. Ito, Masayuki; Miyazima, Shoichi (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 535-8(Mar. 1966). (In Japanese).

Mixtures of propylene and sulfur dioxide were irradiated with γ radiation in the temperature range from 25 to −196°C. The ratio of propylene to sulfur dioxide in polysulfone produced by γ-irradiation was found to be close to unity, independent of temperature and the concentration of propylene. In liquid phase, the polymerization rate increased as the concentration of sulfur dioxide increased and was first order in dose rate. In solid phase, the polymerization rate was maximum when the concentration of propylene was about 50%, and post polymerization was observed in this phase. (NSA of Japan)

17683 RADIATION-INDUCED COPOLYMERIZATION OF CYCLOHEXENE AND SULFUR DIOXIDE. Ito, Masayuki; Kuri, Zenichiro (Univ. of Nagoya, Japan). Kogyo Kagaku Zasshi, 69: 538-41(Mar. 1966). (In Japanese).

Mixtures of cyclohexene and sulfur dioxide were irradiated with γ radiation at +25 to −196°C. The ratio of cyclohexene to sulfur dioxide in copolymers produced by γ-irradiation was found to be close to unity, independent of temperature and the concentration of cyclohexene. The polymerization rate in the liquid phase is first order in dose rate and the addition of DPPH decreases the rate of polymer formation. In solid-phase polymerization, post polymerization takes place. Polymers obtained are soluble in dimethyl formamide and the intrinsic viscosity is 0.1 to 0.3. (NSA of Japan)

17684 RADIATION INDUCED POLYMERIZATION OF ISOPRENE IN THE AQUEOUS SOLUTION OF SILVER NITRATE. Fujioka, Syuji (Toyo Rayon Co., Ltd., Japan); Hayashi, Koichiro. Kogyo Kagaku Zasshi, 69: 736-41(Apr. 1966). (In Japanese).

The formation of a 1:2 complex between isoprene and silver nitrate was confirmed spectrometrically, and the equilibrium constant (κ) and the extinction coefficient (ε) were estimated to be 0.18 and 1.4, respectively. The polymerization mechanism was assumed to be radical based on the effects of inhibitors. The polyisoprene obtained had a cross linked structure and did not give a distinct solubility and melting point. The 1,2-structure was predominant in polyisoprene configuration. (NSA of Japan)

17685 GAMMA-RAY INDUCED GRAFT COPOLYMERIZATION OF STYRENE ON CELLULOSE ACETATE BY AN IMMERSION TECHNIQUE. Hayakawa, Kiyoshi; Kawase, Kaoru (Government Industrial Research Inst., Nagoya, Japan). Nagoya Kogyo Gijutsu Shikensho Hokoku, 15: 383-90(Nov. 1966). (In Japanese).

Effects of radiation intensity, monomer concentration, and other factors on grafting were investigated for the graft copolymerization of styrene on the cellulose acetate fibres by an immersion technique. The initial rate of grafting was proportional to the 0.7th power of the intensity. When benzene was used as a solvent for the monomer, acceleration of the grafting rate as well as an increase in the molecular weight of grafted polystyrene were observed; while both the rate and the molecular weight were reduced when isopropylbenzene was used as a solvent. The results are discussed by considering the energy transfer and the chain transfer between the backbone polymer, the monomer, and the solvent, and also explained by comparing with the homopolymer formation. (NSA of Japan)

17686 RADIATION EFFECTS IN POLYSTYRENE. Kline, Donald E. (Pennsylvania State Univ., State College). J. Appl. Polymer Sci., 5: 191-4(1961).

The effects of reactor radiation on dynamic mechanical properties of polystyrene were investigated. Amorphous polystyrene was subjected to a neutron flux of 0.5×10^{12} neutrons/cm² sec in doses ranging from 1.2×10^{10} to 3.8×10^{11} erg/g. At low temperatures the internal friction of the highly irradiated polystyrene was greater than that of the unirradiated material, and beyond the glass transition, beginning near 370°K, the irradiated sample remained a solid and the internal friction decreased. Below 370°K the dynamic modulus of the highly irradiated material scarcely differed from that of the unirradiated sample, while beyond 500°K it was high (near 10^5 psi). At low irradiation doses sufficient crosslinking occurred for the formation of a nonliquefying, 3-dimensional network in the polystyrene, but no changes in the dynamic mechanical properties attributable to irradiation could be detected. (BBB)

17687 RADIATION CHEMISTRY. Collinson, E. (Univ. of Leeds, Eng.). Ann. Rep. Progr. Chem. (Chem. Soc. London), 62: 79-105(1965).

Advances in radiochemistry of organic compounds since 1961 are reviewed with 217 references to the literature. In a discussion of gaseous organic systems, data are presented relating to the participation of ions, excited molecules, and free radicals in radiation-induced decomposition of hydrocarbons. Properties of radicals are considered. Much work has been done on the properties of the hydrated electron, mostly on constants, by the pulse radiolysis technique, for reaction of e^-_{aq} with itself, with other radicals arising from water, and with added inorganic or organic solutes. Investigations of water in the solid state showed that the response of the solid, and the observation by ESR and optical spectroscopy of stabilized intermediates, may reflect equivalent occurrences in the liquid. The effects observed by ESR in acidic glasses containing a wide range of solutes were interpreted in terms of reactions of mobile electrons and positive holes, which may initially exist in irradiated pure ice in an exciton-like bound state. (TSS)

17688 THE MECHANISM OF THE RADIATION-INDUCED CROSS-LINKING OF POLYOLEFINS. Geymer, D. O. (Shell Development Co., Emeryville, Calif.). Makromol. Chem., 100: 186-99(1967).

The mechanism of radioinduced crosslinking in saturated hydrocarbon polymers was studied by examining the effects of some low-molecular-weight compounds on the radioinduced molecular-weight changes in polypropylene. Polypropylene was selected as a typical polyolefin, because it undergoes both cross-linking and chain fracture in comparable amounts. It was irradiated with ^{60}Co in the presence of various radical scavengers and ion scavengers to determine whether the crosslinking reaction is free-radical or ionic in nature. It was found that iodine and compounds having labile H atoms can inhibit the radioinduced crosslinking. The nature and relative effectiveness of the inhibitors showed that the crosslinking reaction is a rather slow and thermal free radical reaction. The rate of crosslinking of irradiated polypropylene depends on the temperature, and at −196°C it is so slow as to be undetectable. A mechanism for cross-linking in saturated hydrocarbon polymers is proposed. (BBB)

17689 PHYSICOCHEMICAL INVESTIGATION OF SOLID DIMETHYLANILINE. I. DIMETHYLANILINE CONTAINING $FeCl_3$ ACCEPTOR IRRADIATED AT LOW TEMPERATURES. Kosa-Somogyi, Istvan; Tompa, Kalman; Dezsi, Istvan. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 14: 369-82(1966). (In Hungarian).

In measurements of the light emission on the warming up of N,N′-dimethylaniline (DMA) containing ferric chloride and irradiated with ^{60}Co γ rays at 77°K, intensity maxima were observed at 77, 100, 150, and 220°K, indicating structural transformations in the irradiated solution around these temperatures. NMR studies of pure DMA show rotation of the CH_3 group starting at about 77°K. No other structural changes could be inferred from the NMR spectra of the pure material. The radiation chemical light yield varies from 10^{-6} to 10^{-5} photons/100 eV and is seen to decrease exponentially with time. The spectrum lies in the wavelength range from 360 to 600 mμ with a maximum at 490 mμ. Charged particles formed during irradiation are captured by traps with depths varying from 0.1 to 0.7 eV. The light emission is due partly to the recombination of charged particles, partly to excitons. In the radiation chemical process it is mainly the DMA molecules which are subject to excitation. The excitation is assumed to be then transferred from molecule to molecule and eventually to $FeCl_3$ when it causes the $FeCl_2$ to emit. (auth)

17690 EFFECTS OF RADIATION ON MIXTURES CONTAINING FLUOROCARBONS AND THE IDENTIFICATION OF THE PERFLUOROHEPTANE ISOMERS. Askew, William Crews. Gainesville, Fla., Univ. of Florida, 1966. 122p.

Thesis.

Mixtures containing fluorocarbons and some selected pure fluorocarbons were sealed in high-purity Al tubing and irradiated by ^{60}Co gamma rays for absorbed doses of approximately 150 Mrad. The mixtures containing fluorocarbons were also irradiated for periods of one week and four weeks in the Low Intensity Training Reactor at Oak Ridge, Tennessee, at approximately 2×10^{13} neutrons/cm²/sec. The mixtures containing fluorocarbons were: $CF_4 + C_2F_6$, CF_4 + aluminum powder, CF_4 + CO, and CF_4 + carbon granules. The pure fluorocarbons were: CF_4, C_2F_6, C_3F_8, n-C_4F_{10}, i-C_4F_{10}, n-C_5F_{12}, n-C_6F_{14}, 2-$CF_3C_5F_{11}$, 3-$CF_3C_5F_{11}$, and 2,3-$(CF_3)_2C_4F_8$. Analysis of the irradiated samples was by gas chromatography and identification of some radiolysis products

was by mass spectrometry. All of the identified products found can be explained by radical formation and recombination. The yields of fluorocarbon products show that C–F as well as C–C bond rupture occurs during the radiolysis of saturated fluorocarbons. Perfluoromethane is the most abundant of all fluorocarbon products and characterizes the radiolysis of saturated fluorocarbons. The abundance of branched fluorocarbon products indicates that F atoms are more difficult to remove from terminal CF_3 groups than from other carbon atoms in saturated fluorocarbon molecules. Perfluoromethane is the most stable to irradiation of all fluorocarbons studied. Carbon granules and CO probably act as radical scavengers during radiolysis of mixtures containing CF_4 and this causes extreme degradation of the otherwise stable CF_4 to heavier perfluoroalkanes. The presence of aluminum powder during irradiation causes little change in the radiolysis products of CF_4. No unsaturated or cyclic products were found in the radiolysis products of the saturated fluorocarbons. Three products that contain oxygen, C_2F_6O, C_3F_8O, and $(C_2F_5)_2O$, were identified and other unknown products are probably oxygen-containing fluorocarbons. The oxygen-containing products are probably formed by radical recombination at the sample tube wall. No corrosion was found in the sample tubes and material balances show that essentially no fluorine is lost during radiolysis of saturated fluorocarbons. Molecular fluorine was not found in any of the radiolysis products. Abstraction reactions, disproportionation reactions, and molecular expulsion of F_2 probably do not occur in the radiolysis of saturated fluorocarbons. G values (molecules/100 eV) calculated for the disappearance of the starting material are approximately 2 to 3 and show that saturated fluorocarbons are more stable to irradiation than saturated hydrocarbons. –G for CF_4 is approximately 1. Retension volumes of eight of the nine perfluoroheptane isomers were determined and the normal boiling points of these compounds were estimated. The perfluoroheptane isomer, 2,2-$(CF_3)_2C_5F_{10}$, was not found in any of the radiolysis products and no other fluorocarbon products with neo structures were found. (Dissertation Abstr.)

17691 FISSION PRODUCT DEGRADATION AND NEUTRON MODERATING PROPERTIES OF FLUOROCARBONS. Scott, Thomas Howard. Gainesville, Fla., Univ. of Florida, 1966. 144p.

Thesis.

The radiolysis of perfluorodimethylcyclohexane by γ radiation and by reactor radiation was studied. The primary product was a dimeric material with small amounts of gaseous products including CF_4, C_2F_6, C_2F_6O, C_3F_8, and C_3F_8O. The production of dimer and gaseous products was found to be a linear function of the total dose. An expression was derived that related the fraction of sample remaining after exposure to a known dose. This expression was modified to correlate all available data for the irradiation of alicyclic and aliphatic fluorocarbons. A separate expression was found for aromatic fluorocarbons. The expressions hold over a wide range of total doses, dose rates, and for several different types of radiations. The decomposition of C_8F_{16} in a solution of C_8F_{16} and UF_6 exposed to reactor irradiation was investigated. Techniques were developed for the preparation of solutions and for the subsequent separation of the C_8F_{16} from the UF_6 and the fission fragments. The primary products were CF_4, C_2F_6, and C_2F_6O in roughly equal proportions. No dimeric material was found. The kinetics of this reaction supported the assumption that fission fragments shatter the C_8F_{16} into fragments, which are then saturated with fluorine present in the system. (Dissertation Abstr.)

17692 METHOD FOR PRODUCING FOAMED POLYOLEFINE. Takahashi, Toshimasa (to Toyo Rayon Co., Ltd.). Japanese Patent 1965-29187. Dec. 24, 1965. Filed Aug. 9, 1963.

A method is proposed for producing a material of cellular polyolefin plastics. Polyoxymethylene resin (1 to 10 wt %) and polyolefin resin are mixed together, melted, and irradiated with 1 to 20 MRAD of ionizing radiation. Polyoxymethylene resin is stable in the dispersed state, producing no foams, but on irradiating it is degraded to polyoxymethylene having low molecular weight, and on heating decomposes to formaldehyde gas. This decomposition does not take place all at once as in usual foam-solids, but under constant temperature it occurs gradually. Thus, not only the gas evolution can be controlled by the temperature, but the foam-producing rate can be controlled by both the radiation dose and temperature, leading to good foamed bodies. The irradiation dose is chosen to prevent decomposition of the cellular foams by suitable crosslinking but not to prevent the necessary flow of polymer in foaming by the crosslinking. (NSA)

17693 IMPROVED METHODS FOR MANUFACTURING GRAFTED POLYESTERS. (to Japanese Association for Radiation Research on Polymers). British Patent 1,054,269. Jan. 11, 1967. Priority date June 29, 1962, Japan.

A method for the production of graft polymers of a polyester with vinyl or vinylidene monomers consists of carrying out the polymerization in the presence of a swelling agent for the polyester. Suitable swelling agents are one or more of an organic saturated acid; an organic saturated acid anhydride, salt, or ester; an organic acid; an inorganic acid salt; an alcohol free from ethylenic unsaturation; an organic halogen compound free from ethylenic unsaturation; dimethylformamide; dimethyl sulfoxide; formalin; acetonitrile; benzonitrile; adiponitrile; cyclohexylamine; xylene; acetophenone; acetone; methyl ethyl ketone; or acetaldehyde. The monomer may be used in the liquid or gaseous phase, and the polyester can be in any suitable form, e.g. powder, fiber, or film. Various methods may be employed to induce the grafting reaction, e.g. use of ionizing radiation, catalysts, or oxidation reduction reaction. (B.L.M.)

Radiochemistry

Refer also to abstracts 17669, 17673, and 17674.

17694 STUDIES OF CHEMICAL RESULTS OF ^{131}I β DECAY IN THE IODOXYBENZENE. Nefedov, V. D.; Toropova, M. A.; Levchenko, A. V.; Mosevich, A. N. Radiokhimiya, 8: 719-20 (1966). (In Russian).

Experimental studies showed that $^{131m}XeO_3$ was formed during ^{131}I β decay in iodoxybenzene diluted with acetic and perchloric acid solutions. An additional confirmation of xenon trioxide formation was found by observing accumulations in alkaline iodoxybenzene solutions, which revealed that all xenon formed was in a free state in good agreement with published data about the unstable state of xenon trioxide in alkaline media. (R.V.J.)

17695 KINETICS OF OXIDATION OF IRON(II) FROM RECOIL OF IRON(III) IN CRYSTALS OF POTASSIUM TRIOXALATOFERRATE. Calusaru, A.; Rusi, A. (Institut de Physique Atomique, Bucharest). Radiochim. Acta, 6: 147-50(Dec. 1966). (In French).

In crystals of potassium trioxalateferrate irradiated by neutrons two forms of recoiling iron are found: Fe^{2+} and Fe^{3+}. At room temperature the Fe^{3+}/Fe^{2+} ratio equals 1.28 in the case of crystals with water of crystallization and 0.6 in anhydrous crystals. Examination of thermal glowing showed that oxidation of Fe^{2+} and Fe^{3+} (a reaction that preceeds healing) at low temperatures takes place according to the model of the recombination of pairs, which originally were correlated in a random-walk process. At higher temperatures the oxidation process was very much accelerated. Data from the investigation of the residue led to conclusions about the final state of a total of processes. (auth)

17696 STUDIES OF THE BEHAVIOR OF CARRIER-FREE RADIOISOTOPES. II. THE COLLOID FORMATION OF RADIOACTIVE AND NONRADIOACTIVE EUROPIUM IN SOLUTIONS OF EXTREMELY LOW CONCENTRATIONS. Ichikawa, Fujio; Sato, Tadashi (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 6: 128-33(Dec. 1966).

The effect of radioactivity on the radiocolloid formation of europium was described. The centrifugal behavior of radioactive and of nonradioactive europium was compared as a function of the pH of the solution at extremely low europium concentrations. The concentration of nonradioactive europium was determined by activation analysis. No difference was observed between the behavior of radioactive and of nonradioactive europium. The effects of the europium concentration and of other electrolytes were also studied. Radioactivity did not seem to play an essential role in the radiocolloid formation of europium. (auth)

17697 EFFECT OF MODERATORS ON THE ISOMERIC-TRANSITION-INDUCED REACTION OF ^{82}Br WITH METHANE. Nicholas, J. B.; Merrigan, J. A.; Rack, E. P. (Univ. of Nebraska, Lincoln). J. Chem. Phys., 46: 1996-8(Mar. 1, 1967). (COO–1617-3).

The roles of excess kinetic energy and thermal processes in the ^{82}Br reaction in gaseous CH_4 activated by ^{82m}Br isomeric transition were investigated using rare gas moderators and bromine additives. The effects of He, Kr, Xe, and Br_2 moderators are shown. It was concluded that at zero mole fraction moderator the extent of ^{82}Br reaction was 7.4% ± 0.5%. The data appeared to extrapolate, at zero mole fraction CH_4, to 3.7 ± 0.5% for the He, Kr, and Xe additives and to 0% for Br_2. This would indicate that 7.4 – 3.7% is formed via excess kinetic-energy processes and that 3.7% of the organic ^{82}Br is formed via thermal processes. (M.C.G.)

17698 EXCITATION FUNCTIONS AND RECOIL RANGES OF SOME ISOTOPES IN THE NICKEL REGION. Ewart, Hugh Alan. Rochester, N. Y., Univ. of Rochester, 1965. 149p.

Thesis.

The excitation functions and recoil ranges for ^{56}Ni, ^{57}Ni, ^{55}Co, ^{56}Co, ^{57}Co, and ^{58}Co resulting from the bombardment of ^{56}Fe with 20- to 69-MeV helium ions were measured. The excitation functions for the production of ^{56}Ni, ^{57}Ni, ^{55}Co, ^{56}Co, and ^{57}Co from the bombardment of ^{58}Ni with 8- to 40-MeV protons were measured. All of the experimental recoil range curves, when compared with the theoretical ranges of Lindhard, Scharff, and Schiott, were found to be consistent with a reaction mechanism proceeding by full momentum transfer. The experimental excitation functions resulting from the helium ion bombardment of ^{56}Fe were compared with three sets of statistical model calculations. The first calculation was a conventional statistical model calculation using the form of the nuclear level density, $\rho(E) = C(E - \delta)^{-2} \exp\{+2\sqrt{a(E-\delta)}\}$, where C is a constant, δ is a correction for the pairing energy, and a is the level spacing parameter. In the second calculation the influence of shell effects on the nuclear level density was considered. The form of the level density used was $\rho(E) = C(E + \Delta E - \delta)^{-2} \exp\{2\sqrt{a(E + \Delta E - \delta)}\}$, where ΔE is a correction for shell effects. The third calculation took into account both the effect of nuclear shell structure and the effect of the large amount of angular momentum present in the system. This was done by allowing part of the excitation energy to be tied up as rotational energy, yielding a level density expression of the form $\rho(E) = C(E + \Delta E - \delta)^{-2} \exp\{2\sqrt{a(E + \Delta E - \delta)}\} \times \exp(-J^2/2\sigma^2)$, where J is the total angular momentum of the nucleus, and σ is the spin cutoff parameter. The three sets of calculations were compared with the experimental excitation functions. The comparison suggests that the $f_{\frac{7}{2}}$ shell has an important effect on the nuclear level density and that the angular momentum in the system can affect the peak position, shape, and magnitude of the experimental excitation function. The experimental excitation functions resulting from the bombardment of ^{56}Fe with helium ions are compared with those from proton bombardment of ^{59}Co by Sharp, Diamond, and Wilkinson. (Diss. Abstr.)

Separation Processes

Refer also to abstracts 17583, 17601, and 19401.

17699 (BNWL-354) ENGINEERING DEVELOPMENT OF THE SALT CYCLE PROCESS. Jansen, G. Jr.; Mudge, L. K.; Smith, P. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 158p. Dep. mn. CFSTI $3.00 cy, 10.65 mn.

The pilot plant production of electrolytic uranium dioxide and the development of equipment to be used in remote processing of irradiated mixed PuO_2-UO_2 fuels are presented. The process steps are fuel decladding, oxidation of UO_2 to U_3O_8, dissolution in molten salts with chlorine and hydrogen chloride gases, electrolytic deposition of oxides, product purification, crushing and sizing, and off-gas treatment. (auth)

17700 (CISE-103) REVERSED-PHASE PARTITION CHROMATOGRAPHY IN INORGANIC CHEMISTRY: A SURVEY ON RESULTS OBTAINED AT CISE. Cerrai, Enrico (Centro Informazioni Studi Esperienze, Milan (Italy)). Oct. 1966. 46p. Dep. mn.

Methods for the separation of chemical elements and analogies between ion exchange liquid-liquid systems and reversed-phase chromatography are described. Different eluents; such as bis(2-ethylhexyl) phosphate, tri-n-octylamine, and tri-n-octylphosphine oxide, were used for the chromatographic separations. Mechanisms for the systems are given. (P.C.H.)

17701 (DP-MS-66-40) DESIGN OF A CLOSE-COUPLED ANALYTICAL FACILITY FOR CURIUM PROCESS CONTROL. Carothers, G. A.; Dukes, E. K. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). Aug. 26, 1966. Contract AT(07-2)-1. 16p. (CONF-660933-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 10th Conference on Analytical Chemistry in Nuclear Technology, Gatlinburg, Tenn.

The design of an analytical facility for curium process control is described. Kilogram quantities of curium are produced by successive reactor irradiations of plutonium. The essential factors influencing design in addition to radiation control were: speed requirements for certain key analyses; limited space; and the prospect of relatively short-term use, which required minimization of cost. In its final design, the analytical facility covers 550 ft^2 in three modules and will cost $103,000. The facility is close-coupled to the process to minimize the time loss in containing and transporting samples. The working boxes are versatile in design and multipurpose in function. (P.C.H.)

17702 (EUR-2581.f) DECONTAMINATION ULTIME EN ^{90}Sr DES SOLUTIONS CONCENTREES DE PRODUITS DE FISSION PAR EXTRACTION AU D 2 HPA. Rapport Annuel, 1961-1962. (Ultimate ^{90}Sr Decontamination of Concentrated Fission Products Solutions by D2-HPA Extraction. Annual Report, 1961-1962). Lefevre, J.; Serrini, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1965. 33p. (In French). Dep. mn.

The second stage in the ^{90}Sr decontamination of concentrated solutions of fission products is reported. The first stage, aimed solely at production, consists in precipitating the strontium in oxalate form. The residual solution of fission products, partially neutralized and complexed by the oxalates, can be decontaminated straightaway by liquid extraction using bis(2-ethylhexyl) phosphate (DEHPA liquid) without any modifications. An examination was carried out with regard to the stability of the residual production solution in the event of storage prior to decontamination. This treatment gives an additional decontamination factor of 2,000 for four theoretical extraction stages under the conditions studied. (auth)

17703 (EURAEC-1785) REPROCESSING OF IRRADIATED FUELS. Quarterly Report No. 25, April 1-June 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contracts 006-65-7 RCIB (RD); 016-65-1 RAP B. 75p. (EUR-3327). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

The study of reprocessing cycles using chlorine fluorides as fluorinating agents was continued, and that of reactions between uranium and plutonium on the one hand and chlorine trifluoride and chlorine monofluoride, as well as mixtures of chlorine trifluoride and chlorine, on the other hand, was intensified. Chlorine trifluoride reacts with plutonium to form plutonium hexafluoride. This reaction, which becomes appreciable above 200°C, is put down to the fluorine from chlorine trifluoride dissociation. It was verified that the addition of chlorine to the chlorine trifluoride acted against the formation of plutonium hexafluoride because, among other reasons, of the presence of the chlorine monofluoride produced by the mixture. The latter is a selective fluorinating agent for uranium. It reacts easily with uranium compounds in powder form, whereas it gives only a slow attack on compact uranium dioxide. Research on the decanning and behavior of compact uranium dioxide under mixtures of hydrogen fluoride and oxygen was continued. With a view to replacing the towers for washing fluorinating agents and fission product fluorides by columns containing solid absorbents, research was carried out on the possibilities of soda lime. This compound is quite suitable for chlorine, fluorine, and chlorine fluorides. Its behavior in relation to the volatile fission products is encouraging. (auth)

17704 (LA-DC-8393) A STUDY OF SOME GEOMETRICAL AND MECHANICAL EFFECTS ON THE EXTRACTION OF EUROPIUM BY LITHIUM AMALGAM FROM AQUEOUS LITHIUM CITRATE ELECTROLYTES. Goddard, John B.; Campbell, John M.; Onstott, E. I. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 11p. (CONF-670502-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Presentation at 6th Rare Earth Research Conference, Gatlinburg, Tenn.

The amount of Eu extracted into a lithium amalgam from aqueous lithium citrate electrolytes was enhanced when the phases were separated by dumping the amalgam and electrolyte from the reaction vessel into a second vessel containing a chloroform layer to constrain the electrolyte phase. As much as 39% of the Eu in the electrolyte was extracted in a time interval estimated to be less than one second using this phase separation procedure. If the phases were separated by a second technique by adding the chloroform layer to the reaction vessel, other conditions remaining the same, the amount of Eu removed in this time interval was reduced to 3.5%. The amount of Eu extracted by this faster mechanism was found to increase with the amount of amalgam used whereas the steady-state rate was inversely dependent on this parameter. Surface area of the amalgam exposed to the electrolyte affected the steady-state extraction rate in the expected manner with the rate being proportional to surface area, but a change in the surface area of the amalgam exposed to the electrolyte did not significantly affect the extraction of Eu by the faster mechanism when the amount of amalgam was kept constant. (auth)

17705 (MLM-1389) TRITIUM REMOVAL FROM GASES. Poitras, J. P. (Mound Lab., Miamisburg, Ohio). Sept. 30, 1966. Contract AT-33-1-GEN-53. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The tritium concentration of a gas mixture consisting primarily of helium was reduced from 10^{-2} mole percent to 2×10^{-12} mole percent. Adsorption experiments on activated charcoal at 77 and 4.2°K were conducted using various traps, and the results compared. Adsorption on charcoal at 77°K, with traps of large surface areas, was most efficient and practical. The tritium was then

removed from the gas (mainly air) which had been cryogenically adsorbed by the charcoal. This was done by using a catalyst, Hopcalite, heated to 725°C, to form tritiated water which was then adsorbed on a molecular sieve. (auth)

17706 (NP-16598) EXPERIMENTS IN THE EUROCHEMIC EXTRACTION-EVAPORATION PILOT PLANT ON THE FIRST CYCLE OF THE HEU FLOWSHEET. De Witte, R.; Geens, L.; Van Bylen, J.; Centeno, J. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Oct. 1966. 34p. (ETR-198). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experimental work done in the extraction-evaporation pilot plant to assess the performance of the acid-deficient flowsheet chosen for processing of U-Al fuels at Eurochemic is described. It was proved that the equipment and instrumentation of the first cycle of the LEU flowsheet can also be used for the HEU first cycle and that the proposed chemical flowsheet is efficient enough from the point of view of uranium recovery. In this flowsheet, the HA column is the capacity limiting unit in the first cycle. The HETS values of uranium in the HA and 1C columns are, respectively, of the order of 1.70 and 2.70 m. The nature of the experiments does not allow the decontamination factor to be evaluated, but from literature data, the length of the scrubbing columns and some tentative tests of their performance, it is expected that the flowsheet can attain the decontamination factor required (10^5) for the first cycle. Concentration factors for HAW solutions of the order of 1.9 can be safely applied in a climbing film evaporator and overall heat transfer coefficients between 1270 and 1380 $kcal/h \cdot m^2 \cdot °C$ were found. The mixing speed in the Colven-type solvent recovery mixer-settler should be kept lower than 250 rpm to avoid emulsions. (auth)

17707 (ORNL-TM-1730) CONSIDERATIONS OF LOW PRESSURE DISTILLATION AND ITS APPLICATION TO PROCESSING OF MOLTEN-SALT BREEDER REACTOR FUELS. McNeese, L. E. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Distillation at low pressure was examined as a method for removing rare earth fluorides from the fuel stream of a molten-salt breeder reactor. It was concluded that distillation allows adequate rare earth fluoride removal with the simultaneous recovery of more than 99.5% of the fuel salt. Characteristics of equilibrium and molecular distillation were noted and expressions for the relative volatility of rare earth fluorides were derived for these types of distillation. Expressions for the separation potential of several modes of distillation were derived and reported rare earth fluoride relative volatilities were found to allow a great deal of latitude in still design and operational mode. It was concluded that a single contact stage such as a well mixed liquid pool provides adequate rare earth fluoride removal and that rectification is not required. The buildup of rare earth fluorides at the vaporization surface was found to seriously reduce the effectiveness of a distillation system. Liquid circulation was found to be an effective means for preventing buildup of rare earth fluorides at vaporization surfaces. (auth)

17708 SYSTEMATIC INVESTIGATIONS ON THE SEPARATION OF $^{90}Sr/^{90}Y$ AND OF $^{140}Ba/^{140}La$ BY USE OF DOWEX-50 AS ION EXCHANGER AND LACTIC ACID AS COMPLEX FORMER. Lieser, K. H.; Baechmann, K. (Technische Hochschule, Darmstadt, Ger.). Z. Anal. Chem., 225: 379-91(Feb. 3, 1967). (In German).

Ion exchange as a function of time and pH dependence of the partition coefficients for Sr, Y, Ba, and La were measured, in order to find the optimum conditions for the separations $^{90}Sr/^{90}Y$ and $^{140}Ba/^{140}La$. The pH dependence of the partition coefficients and the separation factors are discussed in detail. To investigate the "milking" systems $^{90}Sr/^{90}Y$ and $^{140}Ba/^{140}La$ the activity distribution in the columns and in the eluate as well as the decontamination factors were measured. The optimum conditions for the separations are given. (auth)

17709 THE USE OF KIESELGUHR FOR DECONTAMINATING SEWAGE CONTAINING ^{137}Cs. Otto, R.; Hecht, P. (Institut fuer Angewandte Radioaktivitaet, Leipzig). Atompraxis, 13: 27-9 (Jan. 1967). (In German).

The use of kieselguhr for decontaminating laboratory sewage containing ^{137}Cs is described. Model water systems were either filtered through a layer of kieselguhr, or stirred with kieselguhr. An efficiency of up to 99.9% can be obtained, depending on the amount of foreign matter in the water. (auth)

17710 CHROMATOGRAPHIC SEPARATION OF Ga, In, Zr, AND UO_2. Gupta, S. S.; Mukerjee, D. (Lucknow Univ., India). Z. Anal. Chem., 226: 201-2(Feb. 15, 1967).

A method was developed for chromatographic separation of metal ions that form coordination compounds with mandelic acid. Studies were conducted on mixtures of Ga^{3+}, UO_2^{2+}, In^{3+}, and Zr^{4+} (P.C.S.)

17711 SEPARATION OF BORON ISOTOPES. VIII. BF_3 ADDITION COMPOUNDS OF DIMETHYL ETHER, DIMETHYL SULFIDE, DIMETHYL SELENIDE, DIMETHYL TELLURIDE, DIBUTYL ETHER, AND ETHYL FORMATE. Palko, A. A.; Drury, J. S. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 2297-2309(Mar. 15, 1967). (ORNL-P-2651).

Studies were made of the physical and chemical properties of molecular addition compounds formed by BF_3 and Group VIb donors. The dimethyl telluride complex was too unstable to exist at temperatures above -30°C. The freezing point of the 1:1 dimethyl selenide $\cdot BF_3$ compound was -43°C. From room temperature to its freezing point, the saturation pressure of the 1:1 dimethyl selenide complex was given by $\log_{10} P = 9.945 - (1824/T)$. The 1:1 butyl ether and ethyl formate complexes formed at 25°C but deteriorated slowly with the formation of noncondensable gases. The freezing points of these complexes were -30 and -8°C, respectively. Between room temperature and their freezing point, the saturation pressures of freshly prepared $Bu_2O \cdot BF_3$ and $HCOOEt \cdot BF_3$ were given by $\log P = 5.65 - (1010/T)$ and $\log P = 5.70 - (1330/T)$, respectively. For the same temperature range, the equilibrium constant for the isotopic exchange reaction, $^{10}BF_3(g) + A \cdot {}^{11}BF_3(l) = {}^{11}BF_3(g) + A \cdot {}^{10}BF_3(l)$, was given by $\log K_{eq} = (8.13/T) - 0.0131$, when A was dimethyl selenide and $\log K_{eq} = (1.6/T) + 0.0059$, when A was dibutyl ether. Previously reported equilibrium constants for the Me_2O and Me_2S exchange reactions were redetermined: for Me_2O, $\log K_{eq} = (8.76/T) - 0.0179$, and for Me_2S, $\log K_{eq} = (10.7/T) - 0.0200$. Related thermodynamic data were also computed. (auth)

17712 SEPARATION OF RARE EARTH METALS AND Fe BY DISTILLATION IN AN ELECTRON BOMBARDMENT FURNACE. Trombe, Felix; Male, Germain (CNRS, Hauts-de-Seine, France). Compt. Rend., Ser. C, 264: 199-202(Jan. 9, 1967). (In French).

The possibility of separating Fe and the rare earth metals by distillation under high vacuum was studied. A theoretical study of the separation conditions is given. By applying the calculation predictions, Fe was separated from La by treatment in an electron-bombardment furnace. (tr-auth)

17713 ADSORPTION OF THE RARE EARTH ELEMENTS ON AN ANION-EXCHANGE RESIN FROM NITRIC ACID-ACETONE MIXTURES. Alstad, J.; Brunfelt, A. O. (Univ. of Oslo). Anal. Chim. Acta, 38: 185-92(May-June 1967).

The Dowex I-X8 resin with a nitric acid-acetone medium was investigated for separating the rare earth elements. The lighter elements were easily separated; however, under the conditions for optimal separation of the heavy lanthanides, the distribution coefficients were too high for conventional column separation of all the rare earths, i.e., the ratio between the amount of ion exchanger and the solvent in a column was too high for a straightforward application of the system. (P.C.S.)

17714 ION EXTRACTION BY FOAM: SEPARATION OF URANIUM FROM VANADIUM IN CARBONATE MEDIUM. Jacobelli-Turi, Carla; Barocas, Alberto; Terenzi, Stefania (Univ., Rome). Ind. Eng. Chem., Process Design Develop., 6: 161-2(Apr. 1967).

Uranium and vanadium were extracted from carbonate solutions by a foam technique. Uranium was separated from vanadium by selective stripping of the foam. (auth)

17715 ION EXTRACTION BY FOAM: SEPARATION OF URANIUM FROM THORIUM IN HYDROCHLORIDE MEDIUM. Jacobelli-Turi, Carla; Terenzi, Stefania; Palmera, Mario (Univ., Rome). Ind. Eng. Chem., Process Design Develop., 6: 162-5 (Apr. 1967).

Uranium is separated from thorium in a hydrochloride medium by means of the foam obtained from a quaternary surfactant. Uranium extraction is dependent on the ion association of the quaternary surfactant with the uranyl chloroanionic complex. (auth)

17716 PILOT PLANT DEVELOPMENT OF AN ELECTROLYTIC DISSOLVER FOR STAINLESS STEEL ALLOY NUCLEAR FUELS. Lakey, L. T.; Kerr, W. B. (Phillips Petroleum Co., Idaho Falls, Idaho). Ind. Eng. Chem., Process Design Develop., 6: 174-9(Apr. 1967).

A horizontal, solution-contact, electrolytic dissolver suitable for the continuous processing of spent nuclear fuel elements containing stainless steel-UO_2 cermets was developed on a pilot-plant scale. Elements to be dissolved are charged horizontally into a nonconducting basket placed between two electrodes having a dc potential difference of 20 V and immersed in a nitric acid solution. Heat is removed by continuously circulating the electrolyte through an external cooler. Metal dissolves at a rate of 0.66 g/A-hr when the dissolver is operated at an average anode current density of 1.59 A/cm^2 and the product solution contains 50 grams of dissolved metal per liter. Element size has a greater

effect on current utilization than element composition; smaller elements dissolve at a higher current utilization. Maximum current occurs at electrolyte temperatures near 50°C and at acid concentrations varying from 6.5M for pure solutions to 3M at a metal concentration of 90 grams per liter. Less than 0.05% of the uranium is retained in undissolved solids, which constitute 1 to 3% of the dissolving fuel. Gelatin added to the electrolyte at concentrations between 100 and 200 ppM prevents the formation of adherent coatings of undissolved solids on surfaces in the dissolver system. The undiluted off-gas contains less than 6% hydrogen. Construction materials suitable for the dissolver include platinum for the anode, niobium for the fuel basket, and titanium for the dissolver shell, which also acts as the cathode. (auth)

17717 METAL-ION SEPARATION BY DIALYSIS THROUGH SOLVENT MEMBRANES. Bloch, Rene; Finkelstein, Armand; Kedem, Ora; Vofsi, David (Weizmann Inst. of Science, Rehovoth, Israel). Ind. Eng. Chem., Process Design Develop., 6: 231-7 (Apr. 1967).

High-specificity membranes for selective ion transport are described. In contrast to common dialysis and electrodialysis membranes, discriminating the passage of species because of either size or charge, the present membranes appear to involve a simple solubility mechanism. With the aim of utilizing such membranes as a tool for hydrometallurgical separations, an acid feed solution containing uranyl, iron, aluminum, and nitrate ions was chosen for study. When a polymeric membrane containing an alkyl ester of phosphoric acid was used, uranyl nitrate could be separated from this solution with practically complete selectivity. Permeability depended principally on the distribution coefficients between the aqueous phases in contact with the membrane and the membrane phase. To be of practical value, the lifetime of the membranes would have to be extended. (auth)

17718 TRILAURYLAMINE EXTRACTION OF NEPTUNIUM AND PLUTONIUM FROM PUREX PROCESS WASTE. Schulz, W. W. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Ind. Eng. Chem., Process Design Develop., 6: 115-21(Jan. 1967). (BNWL-SA-106; CONF-650401-15).

A batch solvent extraction process, used to recover ^{237}Np from radioactive waste solutions generated during processing of irradiated uranium in the Hanford Purex Plant, was used to recover the small amount of plutonium lost to the waste stream in Purex process operation. Trilaurylamine diluted with kerosene was used as the extractant. Hydrazine added to the acidic waste converted plutonium to the 4+ valence state for maximum extraction. More than 95% of both elements was extracted in a single batch contact of equal volumes of solvent and waste. Both elements were stripped from the solvent effectively by contact with dilute hydroxylamine sulfate or sodium sulfate–ferrous sulfamate solution. A satisfactory feed solution for final purification of the recovered neptunium and plutonium by the tributyl phosphate solvent extraction procedures used in the Hanford Purex Plant can be prepared from either strip solution. Trilaurylamine solutions have limited chemical and radiolytic stability when in contact with the waste solution. (auth)

17719 USE OF SYNTHETIC INORGANIC ION EXCHANGERS IN THE SEPARATION URANIUM, PLUTONIUM, AND FISSION PRODUCTS. Parra, M. Rodriguez; Hueda, A. Uriarte; Perez, B. Lopez (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 62: 1275-86(Dec. 1966). (In Spanish).

The variation of the distribution coefficients (K_D) for uranium cesium and plutonium ions in nitric solutions with two inorganic ion exchangers was studied. The exchangers were silica gel (<200 mesh) and Unfired Vycor Glass No. 7930 (100–200 mesh). Previously the exchangers were treated with 5M nitric acid and dried at 100°C. The effect of the nitric acid on the capacity of the exchangers was studied. The equilibrium times were determined. The effects of the temperature, nitric acid and concentration, and ion concentration in the aqueous phase on the distribution coefficients were studied. Complete separations between uranium and cesium, and between uranium and plutonium were achieved, because uranium was not fixed into the exchangers in the conditions tried. The separation between cesium and plutonium was almost complete at 50°C; at that temperature the distribution coefficients for cesium with both exchangers were about zero, and those for plutonium were about eight. (auth)

17720 DECONTAMINATION OF RADIOACTIVE WASTES BY MEANS OF SALTS OF FATTY ACIDS. von Erichsen, L. (Univ., Bonn). Chem.-Ing.-Tech., 39: 193-8(Feb. 1967). (In German).

Many cationic radionuclides and radiocolloids are coprecipitated by sorption, incorporation, occlusion, or ion exchange when calcium soaps are precipitated from radioactive waste waters containing $CaSO_4$ on addition of potassium soap solutions. This treatment might therefore be suitable as a method of deactivation of radioactive effluents. The decontamination factors are in many cases good to very good. The precipitates, which are of low density, can be separated by filtration, probably also by flotation. (auth)

17721 PROBLEMS ON SEPARATION OF ZIRCONIUM FROM THE SUM OF FISSION FRAGMENTS. Krisyuk, I. T.; Usacheva, N. T. Radiokhimiya, 8: 709-10(1966). (In Russian).

Rapid preparation of short-lived zirconium fragments with a high specific activity was achieved by using pure alkalies and by reducing the accuracy of the final precipitate measurements to the order of ≤0.5% (the interference activities of ≤0.5% were not recorded). Verification of the half-life period of ^{97}Zr (17 hr) separated from irradiated uranium showed that a single precipitation of $BaZrF_6$ and zirconium phenylarsonate (instead of the three-stage precipitation) was sufficient for measurements with an order of accuracy of 0.5%. The rapid method produced zirconium with a small amount of carrier. The ratio of introduced active zirconium to that obtained after purification (within the order of error of 2 to 3%) was equal to 1. The experiment took 3 hr. (R.V.J.)

17722 EXTRACTION OF URANIUM, THORIUM, AND ASSOCIATED ELEMENTS BY MONOCARBOXYLIC ACIDS. Merkin, E. N.; Ivanovskii, M. D.; Borbat, V. F. Radiokhimiya, 8: 705-7 (1966). (In Russian).

Extraction of uranium, thorium, and associated elements by fatty acids of the C_7 to C_9 fractions was studied using a 100-ml separation funnel with the phase ratio 1:1 at 20 ± 2°C. In equilibrium aqueous phases the pH was measured potentiometrically with an order of error up to ±0.05. The elements were further extracted by nitric and hydrochloric acid. The coefficient of distribution of metals increased with increased pH of the aqueous phase. The extraction by fatty acids was realized by cation exchange, which permitted separation of the elements (UO^{2+}, Th^{2+}, Al^{3+}, Fe^{2+}, Fe^{3+}, and Mn^{2+}) in sulfate solutions according to their extraction ability. Combining the data of previous works with the data obtained the extraction series would be: $Sn^{4+} > Bi^{3+} > Fe^{3+} > UO_2^{2+} > Th^{4+} > Pb^{2+} > Al^{3+} > Cu^{2+} > Cd^{2+} > Zn^{2+} > Ni^{2+} > Co^{2+} > Fe^{2+} > Mn^{2+} > Mg^{2+} > Na^+$. (R.V.J.)

17723 MECHANISM OF SALT TRANSITION THROUGH THE PHASE BOUNDARY SURFACE IN EXTRACTION SYSTEMS. Fedorov, V. S. Radiokhimiya, 8: 633-41(1966). (In Russian).

The water extraction of uranyl nitrate from alkyl phosphate solutions was analyzed using absolute reaction-rate correlations. The free energies of certain intermolecular reactions were estimated. The solvent and diluent activity in organic phases was evaluated on the basis of the re-extraction rate and empirical equations were found for the activity coefficients in a binary organic solution. The Lippincott–Schroeder potential bond function and re-extraction activation energy were used for determining the phosphate–uranyl energy bond in uranyl nitrate–alkyl phosphate systems. (R.V.J.)

17724 GAS-CHROMATOGRAPHIC TECHNIQUE FOR RAPID ISOLATION OF URANIUM FISSION PRODUCTS. Denschlag, H. O.; Gordus, A. A. (Univ. of Michigan, Ann Arbor). Z. Anal. Chem., 226: 62-71(1967).

A gas-chromatographic technique for a rapid separation of fission iodine or bromine from the other elements formed in nuclear fission was developed. Recoil-formed, volatile methyl bromide and methyl iodide were isolated within 1 min after the end of irradiation. An extension of this technique to other elements and to other nuclear reactions should be possible. The γ spectra of both halogen fractions were measured. A dominating γ ray at 0.79 MeV and a weaker γ ray at 0.51 MeV were assigned to ^{80}Br (half-life 16 sec). No γ ray could be unambiguously attributed to ^{132}I (24 sec), a fact which makes unlikely the presence of highly intensive peaks in the γ spectrum of this isotope. Further details of the spectra are discussed. (auth)

17725 RAPID RADIOCHEMICAL SEPARATION BY ISOTOPIC AND ION EXCHANGE ON PREFORMED PRECIPITATES. Eckhardt, Wolfram; Herrmann, Guenter; Schuessler, Hans-Dieter (Univ., Mainz). Z. Anal. Chem., 226: 71-88(1967). (In German).

Short-lived nuclides can be isolated by rapid isotopic and ion exchange between their solutions and preformed precipitates by sucking the solution quickly through a thin layer of the precipitate. It is shown with silver halides, cesium, barium, and thallium compounds how the exchange depends on the preparation, amount, and solubility of the precipitate, and on the composition and contact time of the solution. In a few systems not only the surface layer but the whole precipitate or most of it is involved in the rapid exchange. As an application an automatic separation

procedure is described for bromine and iodine nuclides from fission products by exchange with silver chloride, which can be completed within 2 seconds after irradiation. (auth)

17726 SEPARATION OF NEPTUNIUM(IV), NEPTUNIUM(V), AND NEPTUNIUM(VI) BY EXTRACTION CHROMATOGRAPHY. Eschrich, Hubert (Institutt for Atomenergi, Kjeller, Norway). Z. Anal. Chem., 226: 100-14(1967). (In German).

The applicability of reversed-phase chromatography with the partition system tributyl phosphate (TBP)/nitric acid to the separation of neptunium(IV), -(V), and -(VI) was investigated. The amounts of neptunium in the different oxidation states can be quantitatively separated on chromatographic TBP-columns by elution with 0.5 to 2M nitric acid at room temperature and a flow rate of 1 ml × cm^{-2} × min^{-1}. Some analytical and radiochemical applications of the separation method are given and possible interferences are discussed. (auth)

17727 RAPID SEPARATION METHODS FOR CESIUM FROM FISSION PRODUCT MIXTURES. Fiedler, H. J. (Univ., Mainz. McMaster Univ., Hamilton, Ont.); Archer, N. P. Z. Anal. Chem., 226: 114-22(1967). (In German).

Two fast separation methods of cesium from fission products are described, which yield rubidium-free samples. In the first method cesium is twice precipitated as tetraphenyloborate from weak acid solution and then purified from rubidium by precipitating cesium bismuth iodide from acetic acid solution. In the second, faster method cesium is isolated by isotopic exchange with preformed cesium phosphomolybdate in 8N nitric acid and then purified as cesium bismuth iodide. The application of these methods in decay scheme studies of 9.5-min ^{139}Cs, 65-sec ^{140}Cs, 24-sec ^{141}Cs, and 18-min ^{141}Ba is briefly discussed. (auth)

17728 SEPARATION OF RARE EARTHS FROM NUCLEAR FISSION ON CATION EXCHANGERS. Seyb, Karl-Erich (Univ., Mainz). Z. Anal. Chem., 226: 159-70(1967). (In German).

The effect of several operation conditions on the ion exchange separation of rare earths with α-hydroxy isobutyric acid was studied. The composition of the eluant essentially determined the value of the separation factor and the sharpness of the eluted band. Good separations can be accomplished only with complexing solutions containing sufficient amounts of undissociated hydroxy acid. Variations of flow rate near 1 cm/min act on elutions in absence of undissociated hydroxy acid only. Other experiments showed strong temperature dependency of elution positions, but separations were of equal quality in the range of 50 to 83°C. Addition of carrier should be avoided; with amounts above 1 mg per cm^2 column cross section separation quality was reduced remarkably. In order to evaluate ion exchange experiments, the elution curves were plotted on probability graph paper with logarithmic abscissa resulting in straight lines. (auth)

17729 RAPID SEPARATION OF CERIUM AND MOLYBDENUM FROM FISSION PRODUCTS. Michelsen, Odd B.; Hoffman, Darleane (Institutt for Atomenergi, Kjeller, Norway). Radiochim. Acta, 6: 165-7(Dec. 1966).

A 4-min procedure based on extraction with hydrogen di-(2-ethylhexyl) orthophosphoric acid (HDEHP) was developed for separation of cerium from other fission products. Three alternative types of cerium sources were developed: liquid, solid, and column. While this procedure for cerium worked efficiently, a similar one developed for extraction of molybdenum from nitric acid solutions gave samples with extra radiation. This radiation was observed only after most of the Mo–Te radiation had died away, and was thought to be due to contamination of the sample by Te–I isotopes. (P.C.S.)

17730 CONTRIBUTION ON THE CHEMISTRY OF PROTACTINIUM. Dinstl, Georg (Univ., Vienna). Radiochim. Acta, 6: 125-7(Dec. 1966). (In German).

Methods for extracting protactinium with long-chain amines (LA-1, LA-2-Dodecylamin) are described. By adding carriers (^{231}Pa) easily reproducible extraction curves were obtained. An account is given on the use of molecular plating for the production of thin layers of protactinium suitable for the γ spectroscopy of this element. By use of dioxan as organic phase and voltages up to 10,000 V 90% of the protactinium could be deposited on small sheets of special steel. (auth)

17731 EXTRACTION OF SOME LANTHANIDES WITH VARIOUS PHOSPHORIC ACID ESTERS. Krasovec, F.; Klofutar, C. (Jozef Stefan Nuclear Inst., Ljubljana, Yugoslavia). Radiochim. Acta, 6: 114-19(Dec. 1966).

The extraction of Y(III) and some trivalent lanthanides from 1M (H,Na) ClO_4 aqueous phases with chloroform solutions of various phosphoric acid esters was studied. Results indicated that $MA_3(HA)_2$ is the predominant complex extracted with aromatic esters of phosphoric acid while with aliphatic di-n-butyl phosphate $MA_3(HA)_3$ is the complex existing in the organic phase. The formation of the former complex can be alternatively written by following reactions: M^{3+} (aq) + $3A^-$ (aq) + 2HA (org) ⇌ $MA_3(HA)_2$ (org); M^{3+} (aq) + $2.5H_2A_2$ (org) ⇌ $MA_3(HA)_2$ (org) + $3H^+$ (aq). The equilibrium constants of these reactions were calculated. It was observed that a linear relation between log K_3 and log $K_d \cdot K_2^{-1}$ exists. With the aid of this relation an empirical equation was derived, which may be used to predict the efficiency for the extraction of trivalent lanthanides with any aromatic ester of orthophosphoric acid if its acid dissociation (K_a), distribution (K_d) and dimerization (K_2) constants are known. The results further show that a high extraction efficiency will be exhibited by phosphoric acid esters having a high acid dissociation and distribution constant and low dimerization constant. (auth)

17732 DISSOLUTION KINETICS OF NUCLEAR FUELS. 1. URANIUM. Kindlimann, L. E. (Allegheny Ludlum Steel Corp., Brackenridge, Pa.); Greene, N. D. Corrosion, 23: 29-34(Feb. 1967).

Dissolution of uranium was studied by potentiostatic and galvanostatic anodic polarization techniques. Uranium exhibits active-passive behavior in nitric acid, sulfuric acid, and sodium hydroxide. Transpassive dissolution of uranium in acid occurs without gas evolution, giving high current efficiency. At constant potential, transpassive dissolution rate increases with increasing temperature and decreasing acid concentration. These data are discussed in terms of uranium fuel element dissolution processes. (auth)

17733 ON CHELATE FORMATION OF ARYL SULFONATED 1,3-DIPHENYLPROPANEDIONES-1,3 WITH RARE EARTHS. Troeltzsch, Chir (Karl-Marx-Univ., Leipzig). Z. Chem., 6: 432-3(Nov. 1966). (In German).

The Na salt of 1,3-diphenylpropane-1,3-dione-p-sulfonic acid and the disodium salt of 1,3-diphenylpropane-1,3-dione-m,m′-disulfonic acid were studied as chelons for the lanthanides and Y. Values for dissociation constants of the complexes are given. The acids may be used only for separation of the lighter lanthanides on cation exchangers. There is no effect of steric hindrance on at least the log K_1 values. The disulfonic acid salt shows a smaller K_D value, greater acidity, and greater log K_1 values than the monosulfonic acid salt. Previously substitution in 1,3-diketones leading to greater acidity and decreasing chelate stability with respect to a given metal gave only slight changes in the practically important formation constants; the formation constants of the new chelates differ among themselves more than their stability constants. The structures of the complexes are discussed; in acid solution (pH <4) no chelate is formed with La, but only a sulfonate salt. Above pH 8 the value of $\bar{n}$ is >3 with La. (BBB)

17734 METHOD FOR SEPARATING ^{235}U BY MOLECULAR DISTILLATION OF URANIUM HEXAETHOXIDE. Nakane, Ryohei; Oyama, Toshiyuki. Japanese Patent 1966-8280. Feb. 8, 1966. Filed Oct. 20, 1962.

A proposed method for separating ^{235}U by molecular distillation of uranium hexaethoxide, which largely eliminates the drawbacks of the pentaethoxide-distillation method, is capable of effecting separations comparable with the gaseous diffusion method. (NSA of Japan)

17735 METHOD FOR DISSOLVING STAINLESS STEEL MEMBERS. Bennett, M. R.; Cathers, G. I. (to U. S. Atomic Energy Commission). U. S. Patent 3,303,004. Feb. 7, 1967.

A method was developed for dissolving stainless steel-containing members and particularly stainless steel-clad U or Pu fuel elements by contacting the steel or steel-clad fuel element with a gaseous reaction mixture of anhydrous HF and an oxygen-containing gas at a temperature between 550 and 650°C. (auth)

17736 PROCESS OF RECOVERING STRONTIUM, CESIUM, CERIUM, AND RARE EARTH VALUES FROM RADIOACTIVE SOLUTIONS. Bray, Lane A. (to U. S. Atomic Energy Commission). U. S. Patent 3,302,993. Feb. 7, 1967.

A method was developed for coextracting Sr, Cs, Ce, and other lanthanide rare earths from an aqueous solution by adjusting the pH of the solution to from 3 to 5 and contacting the aqueous solution with a substantially water-immiscible aliphatic hydrocarbon solution containing a water-immiscible phenol, such as 4-sec-butyl-2-(α-methylbenzyl) phenol, and a water-immiscible alkyl ester of phosphoric acid, such as bis(2-ethylhexyl) ester phosphoric acid, whereby the Sr, Ce, Cs and lanthanide rare earths are taken up by the aliphatic hydrocarbon solution. (auth)

EARTH SCIENCES

Geology

Refer also to abstract 18370.

17737 RELATION BETWEEN THE ADSORPTION AND DIFFUSION RATE OF MICROQUANTITIES OF STRONTIUM IN THE SOIL. Prokhorov, V. M.; Frid, A. S. Radiokhimiya, 8: 695-6 (1966). (In Russian).

The distribution factor for ^{90}Sr in humid soils is a function of concentration of soil solutions; with an increase of Ca^{2+} from 4×10^{-3} to 0.58N, the coefficient of distribution is reduced 68 times. The relation of the ^{90}Sr diffusion factor to the distribution coefficient for the investigated soil on the logarithmic scale is linear in character. (R.V.J.)

17738 LOW ENERGY GAMMA SCINTILLATION SPECTRUM OF URANIUM ORE. Juliano, Petronilo O. (Philippine Atomic Research Center, Diliman, Quezon City); Yu, Julita. Philippines Nucl. J., 1: No. 1, 43-4(July 1966).

The spectra of uranium ore and chemical standard uranium oxide (U_3O_8) were obtained using a 3 × 3 in. NaI (Tl) scintillation detector, whose pulses after amplification were fed to a multichannel pulse height analyzer. The chemical standard, because of its young age (2½ yrs), showed essentially the spectrum of ^{234}Th. The ore spectrum gave a very large peak at 88 keV with the 63 and 93 keV gammas of ^{234}Th present as mere shoulders. Gamma absorption techniques were used to determine the number of components in the 83 to 103 keV region of the spectrum. Using lead as absorber, the activity as a function of absorber thickness was obtained, and using graphical methods the half-thicknesses of the different component were determined. The uranium ore yielded one component more than the chemical standard. Based on these observations it would be erroneous to attribute all the low energy component merely to ^{234}Th activity and to the Compton contribution of high energy gammas. (D.H.M.)

Meteorology

Refer also to abstract 17751.

17739 (AD-642279) PROJECT STARDUST. Progress Report No. 11, September 1963-September 1965. Feely, Herbert W.; Biscaye, Pierre E.; Davidson, Ben; Seitz, Harold (Isotopes, Inc., Westwood, N. J.). July 1, 1966. Contract DA-49-146-XZ-079. 238p. (DASA-1821). CFSTI $3.00 cy, $0.65 mn.

Work performed on Project Stardust during the two year period September 1963 to September 1965 is reviewed. Changes in the sampling and analytical programs are summarized. The stratospheric distributions of radioactive debris from nuclear weapon tests are described. Nuclides described include strontium-90, cesium-137, plutonium-239, manganese-54, iron-55, antimony-124, yttrium-88, sodium-22, cadmium-109, silver-110 and carbon-14. The stratospheric distributions of plutonium-238 from a SNAP-9A burnup, of several cosmic ray products and of lead-210 and polonium-210 are discussed. Progress in the design of the Stardust numerical model of transfer and rainout of stratospheric radioactive materials is summarized. (TAB)

17740 SINGLE FALLOUT PARTICLES AND ^{95}Zr FROM THE CHINESE NUCLEAR EXPLOSION OF 9 MAY 1966. Baugh, James O.; Yoshikawa, Kazuko; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Science, 155: 1405-7(Mar. 17, 1967). (ORO-2529-7).

Daily fluctuations of the number of single fallout particles and activity of zirconium-95 in the groundlevel air were measured at Fayetteville (94°W, 36°N), Arkansas, for a period of about 3 months after the Chinese nuclear explosion of 9 May 1966. A cyclic pattern of variations for both zirconium-95 and fallout particles was found; this indicated that they were airborne for a long period and traveled far. Apparently, some of the particles circled the world more than once. (auth)

17741 RADIOCHEMICAL ANALYSES FOR ^{137}Cs, ^{90}Sr, AND ^{144}Ce IN RAIN WATER IN SYDNEY. Pallister, E. T.; Green, J. H. (Univ. of New South Wales, Sydney). Austral. J. Sci., 29: 163-4(Dec. 1966).

Analyses were made of rain water in the Sydney area to determine ^{90}Sr, ^{137}Cs, and ^{144}Ce. Results are presented monthly from May 1964 through June 1966. The ^{90}Sr content of packed tea was also determined. (M.C.G.)

17742 GLOBAL CIRCULATION OF RADIOCERIUM ISOTOPES FROM THE MAY 14, 1965, NUCLEAR EXPLOSION. Thein, Myint; Kuroda, P. K. (Univ. of Arkansas, Fayetteville). J. Geophys. Res., 72: 1673-80(Mar. 15, 1967). (ORO-2529-3).

The concentrations of ^{141}Ce and ^{144}Ce in rain were measured at Fayetteville, Arkansas, during the period between November 1964 and December 1965. The $^{141}Ce/^{144}Ce$ data indicate that the radiocerium isotopes produced by the May 14, 1965, Chinese nuclear test explosion traveled eastward and circled around the world at least twice. The mean tropospheric residence halftime of the cerium isotopes was calculated to be approximately 40 days. Measurements of variations of the ratios $^{144}Ce/^{90}Sr$, $^{141}Ce/^{89}Sr$, and $^{141}Ce/^{140}Ba$ in rain yielded experimental evidences for the atmospheric fractionation of nuclear debris. (auth)

Mineralogy

17743 CONTRIBUTION TO THE KNOWLEDGE OF THE RADIOACTIVE CONSTITUENTS OF THE WITWATERSRAND CONGLOMERATE. I. URANINITE IN THE CONGLOMERATES OF THE ORANGE FREE STATE GOLDFIELDS. Schidlowski, Manfred (Univ., Goettingen, Ger.). Neues Jahrb. Mineral., Abh., 105: 183-202(Aug. 1966). (In German).

Microscopic studies were made of detrital uraninite grains in ore samples from Orange Free State conglomerates. New observations on the uraninite fraction of the principal uraniferous reefs of this area are reported. The results obtained lend strong support to genetic concepts advocating a detrital origin for the uraninite, confirming the views first advanced by Ramdohr and Liebenberg. Both the shape and distribution within the conglomerate bands of the uraninite particles indicate that they are: water-worn, abraded constituents of the present mineral assemblage, and part of the original heavy fraction of the conglomerates. Conflicting opinion arising from geochemical considerations is discussed in the light of these observations and other published data bearing on this problem. (BBB)

17744 CONTRIBUTION TO THE KNOWLEDGE OF THE RADIOACTIVE CONSTITUENTS OF THE WITWATERSRAND CONGLOMERATE. II. BRANNERITE AND URANINITE "GHOSTS." Schidlowski, Manfred (Univ., Goettingen, Ger.). Neues Jahrb. Mineral., Abh., 105: 310-24(Nov. 1966). (In German).

A microscopic study showed that brannerite (UTi_2O_6) occurs within the Witwatersrand conglomerates as minute felts of columnar or needle-shaped crystals which indicate their origin as authigenic constituents of the rock. According to an earlier study they formed from uraninite and rutile under pseudohydrothermal conditions ($UO_2 + 2\ TiO_2 \rightarrow UTi_2O_6$). This seems likely, as they usually appear to be closely associated with these two minerals, particularly with rutile. The formation of brannerite must have taken place during the phase of metamorphism to which the ore deposits were exposed, the peaks of which coincide with the volcanism of the Ventersdorp period and the intrusion of the Bushveld Igneous Complex. Often brannerite forms pseudomorphs after uraninite or rutile. Significant are the so-called uraninite ghosts, which are pseudomorphs after detrital uraninite grains which commonly preserve the characteristic shape of these particles. The central parts of the ghosts are mostly leached and the resulting cavities partly filled with secondary recrystallized sulfides, such as chalcopyrite, pyrrhotite, and galena. Just as most uraniferous minerals of the Witwatersrand conglomerates, brannerite shows a characteristic dusting with minute inclusions of galena having formed from radiogenic lead. Along with parts of the sulfide fraction, brannerite sometimes was mobilized and redeposited during metamorphism. These processes of migration and redistribution hardly exceeded distances of 1 cm. They cannot be referred to as a genuine hydrothermal transport, even if the absence of an outside mineralizer is not taken into account. (BBB)

Seismology

Refer also to abstracts 17742 and 17914.

17745 (AD-639197) LARGE APERTURE SEISMIC ARRAY CAPABILITIES. Technical Report. Green, Paul E. Jr.; Wood, Ralph V. Jr. (Massachusetts Inst. of Tech., Lexington, Lincoln Lab.). July 12, 1966. Contract AF 19(628)-5167. 28p. (ESD-TR-66-361). CFSTI $3.00 cy, $0.65 mn.

Results of a study of the effectiveness of the experimental Large Aperture Seismic Array in Montana are presented. An attempt has been made, where possible, to draw conclusions from the study of

this one station about the performance that might be expected from a worldwide net of several of them. Reliability and continuity of observations obtainable from a LASA system, the threshold level for automatic detection and location of weak events, the various signal-to-noise enhancement processes available for on-line and off-line use, and the effect of such enhancements on the ability to discriminate source type are discussed. The engineering approaches and system organization that were chosen appear to have resulted in a system of high reliability in the presence of normal component failures, noise, and seismic interference. The 50 percent detection threshold being currently achieved by relatively crude on-site processing is estimated at magnitude 3.5. Off-line processing gains in signal-to-noise ratio equivalent to a magnitude differential of 1¼ over a single seismometer output are available. The improvement in ability to see waveform features for identification depends on the type of feature being examined. For first motion, it varies with the signal-to-noise gain; for pP, it is significantly larger. (TAB)

17746 (ESD-TR-66-250) SEISMIC DISCRIMINATION. Semi-annual Technical Summary Report to the Advanced Research Projects Agency, January 1–June 30, 1966. (Massachusetts Inst. of Tech., Lexington. Lincoln Lab.). July 28, 1966. 40p.

The capabilities of the experimental Large Aperture Seismic Array (LASA) to detect, reprocess, and identify teleseismic signals have been evaluated. The detailed results are summarized, and current performance of the physical elements of the system is discussed. Exploratory work on the following topics is described: a different method of measuring P-complexity, a novel scheme for wide-band seismometer calibration, processing of signals from a set of three-component seismometers, and a computer simulation of the LASA seismometer channel. (auth)

ENGINEERING

Nuclear Explosions

17747 (ORNL-TM-1775) CHEMICAL APPLICATIONS OF NUCLEAR EXPLOSIONS (CANE). Progress Report, October 1–December 31, 1966. Blake, C. A. Jr.; Brown, K. B.; Crouse, D. J. (comps.) (Oak Ridge National Lab., Tenn.). Feb. 21, 1967. Contract W-7405-eng-26. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The amount of ^{106}Ru contamination in cement copper products increased by a factor of about 2.5 when the initial ruthenium concentration in the copper leach liquor was doubled. The ^{106}Ru in the cement copper also increased with increase in pH and temperature. Green River oil shale has been retorted successfully in the laboratory unit. The oil distilled at shale temperatures between 300° and 350°C and the yield was about the same as obtained by the Fisher assay. In runs where the shale was moistened with tritiated water, less than 0.5% of the tritium was found in the water-scrubbed oil product. Tritium and hydrogen exchange between tritiated water and methane is linear with respect to time and occurs at the rate of 0.7×10^{-6} mCi/liter-day in a liter flask containing methane at approximately 1 atmosphere and ~20 mCi tritium in tritiated water. (auth)

17748 (UCRL-50008-67-1) PLOWSHARE PROGRAM. Vol. II, No. 4, November 1, 1966–January 31, 1967. Rabb, David D. (comp.) (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 31, 1967. Contract W-7405-eng-48. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress on the first Plowshare project involving extensive industrial participation is reported. Funds for the Gasbuggy Project site preparation are available and construction is ready to start. Explosives development, physical measurements, effects on materials, and computer code development in Plowshare's nuclear effects testing programs continued. (L.C.L.)

17749 NEAR-SURFACE SPALLING FROM A NUCLEAR EXPLOSION IN A SALT DOME. Eisler, J. D. (Stanford Research Inst., Menlo Park, Calif.). J. Geophys. Res., 72: 1751-60 (Mar. 15, 1967).

Although near-surface spalling observed on the Salmon nuclear shot resembled that observed on other shots in different environments, the spalling process was more complex because of an artificially filled platform at surface zero. The Salmon maximum spall gap width (0.1 meter) in the vicinity of surface zero was roughly $\frac{1}{6}$ of the width that would be expected without the platform. The radius was 460 meters, and the spalled layer thickness was 11.7 meters. Measurements established that the near-surface layers had experienced multiple bouncing rather than successive spallation. (auth)

17750 COMPARISON OF RELATIVE RADIONUCLIDE RATIOS IN DEBRIS FROM THE THIRD AND THE FIFTH CHINESE NUCLEAR TEST EXPLOSIONS. Aarkrog, A.; Lippert, J. (Atomic Energy Commission, Risoe, Denmark). Nature, 213: 1001-2 (Mar. 11, 1967).

Chinese nuclear test explosions occurred on May 9th and Dec. 28th, 1966. Both explosions corresponded to the few hundred kiloton range. Since a weapon in this intermediate range might be a thermonuclear device, special interest attaches to the debris from these two tests. Air filter and smear tests were taken, the former at ground level at Riso and the latter from aircraft. Examination of samples was by gamma spectrometric analysis. Data are given for ^{95}Zr, ^{99}Mo, ^{103}Ru, ^{131}I, ^{140}Ba, ^{141}Ce, ^{144}Ce, ^{147}Nd, ^{237}U, and ^{239}Np. ^{141}Ce was used as a reference nuclide for comparison between the two tests. Comparison of the debris from the third explosion with that from the fifth explosion showed that debris from the fifth explosion was enriched in nuclides belonging to volatile decay chains (^{239}Np, ^{103}Ru, ^{131}I, ^{140}Ba) as compared with the less volatile ^{99}Mo, ^{147}Nd, ^{95}Zr. ^{237}U was more abundant in the third explosion. While the former observation could be attributed to fractionation phenomena, the ^{237}U difference cannot be explained in this way. The explanation in the latter case might be that some additional ^{237}U was produced by some process other than 2n capture in ^{235}U (possibly n,2n reaction in ^{238}U). The difference could undoubtedly be explained by differences in weapon design. The occurrence of ^{133}Xe is also discussed. (UK)

17751 GAMMA-RADIATION CHARACTERISTICS: ANGULAR DISTRIBUTION OVER A DESERT TERRAIN FALLOUT FIELD. Frank, A. L. (Naval Radiological Defense Lab., San Francisco). Health Phys., 12: 1715-31(Dec. 1966).

A gamma-radiation spectroscopy experiment was carried out at the Nevada Test Site near Mercury, Nevada in the summer of 1962. A gamma-ray NaI scintillation spectrometer was taken onto a fallout-contaminated desert terrain. Measurements were made at ten vertical angles at 9 days after shot time. All data were for a detector height of 4 ft. The pulse height data were reduced to photon spectra (photons/min-MeV-in.^{2}-steradian) by means of a matrix iteration procedure. Some comparisons were made between the vertical-angle photon spectra and data from other sources. Also a calculation of the effective ground roughness of the desert terrain was made by the absorbing overlayer model. This resulted in a calculated overlayer of approximately 24 equivalent ft of air. (auth)

Facilities and Equipment

Refer also to abstracts 17776, 17795, 17810, 18547, 18548, 18559, 18565, 18605, and 18606.

17752 (EUR-3130.f(Vol.3)) ETUDE DU CHARRIAGE D'UN ECOULEMENT PAR TRACEURS RADIOACTIFS. TECHNOLOGIE DES MESURES DE TRANSPORT SOLIDE PAR TRACEURS RADIOACTIFS. (Bed-Material Transport Study by Tracers. Technology of Sediment-Transportation Measurements by Use of Radioactive Tracers). Heuzel, M. (Electricite de France, Paris). Dec. 1966. Contract 019-62-12 IRAF. 34p. (In French). Dep. mn.

Sediment transport was measured using ^{198}Au, ^{192}Ir, and ^{182}Ta as tracers. The sediment included muds, pebbles, and sand. New apparatus tested included an injection device intended for the continuous injection into the mud load of a dredge; a sampler which picks up undisturbed samples of mud or sand from the bottom; and an analyzer. (F.S.)

17753 (Y-1570) A BIDIRECTIONAL PRECOUNTER FOR INTERFACING SMALL COMPUTERS TO MACHINE CONTROL. Arrowood, J. L.; Groppe, W. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 28, 1967. Contract W-7405-eng-26. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Due to the many requirements imposed upon it, the feedback counting system necessary in using a digital computer to control a machine tool is complicated and expensive. A simple, inexpensive circuit was designed which would eliminate some of these requirements by operating upon the feedback signal before it was received by the counter. This provision allows a fairly simple counting system to be used. (auth)

17754 (NP-tr-1513) ELECTRICAL PROTECTION OF A CLOSED SOLENOIDAL SYSTEM. Burchenko, P. Ya.; Volkov, E. D.; Georgievskii, A. V.; Ziser, V. E.; Kitaevskii, L. Kh.; Pogozhaev, D. P.; Svetlichnyi, V. E. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Culham Lab., Abingdon, Eng., from report FTI-216/P-068. 6p. (CTO-349). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

An electrical protection system is described for use with thermonuclear devices using closed solenoidal magnetic systems for plasma confinement. The system prevents damage in the case of magnet coil failures. (M.O.W.)

17755 URANIUM AND COAL: RIVALS OR PARTNERS? Weinberg, Alvin M. (Oak Ridge National Lab., Tenn.). Mech. Eng., 89: No. 3, 32-5(Mar. 1967).

The rivalry between fossil fuels and uranium and the increasing importance of the role of energy in our society are discussed. The advantages and disadvantages of nuclear energy and coal are summarized. Methods for capitalization on the advantages of coal and for minimizing its disadvantages are discussed. The possibility of using a boiling K topping cycle in a dual system in order to obtain a thermal efficiency of 55% for nuclear reactor produced electricity is discussed. (F.S.)

17756 GAS TURBINE STANDBY AT OLDBURY NUCLEAR POWER STATION. Engineer, 223: 405-6(Mar. 17, 1967).

The standby plant for essential electrical services at the 580 MW(e) power station consists of three 2.5 MW turbo-alternators each driven by a Bristol Siddeley Proteus engine, one set for each reactor and one reserve. Starting is initiated by interruption of the normal grid supplies and power is restored in 90 sec. The design and layout of the equipment and its integration into the system are described. (UK)

17757 X RAY APPARATUS FOR INTRACELLULAR MICRO-IRRADIATIONS. Geissler, Karol; Wilczok, Tadeusz; Neumann, Henryk (Inst. of Oncology, Gliwice, Poland). Nowotwory, 16: 363-8(Oct.-Dec. 1966). (In Polish).

The construction of x-ray microbeam apparatus for partial cell irradiation with a new type of microcollimator is described. The microcollimators are changeable so a field of 1 to 10 μ^2 can be irradiated. The microbeam is movable in two directions over the irradiated field. The irradiation times are 1 sec to 5 min. (auth)

17758 THE "NAYADE" ^{60}Co IRRADIATION UNIT. Fornas Izquierdo, E.; Del Val Cob, M.; De La Cruz Castillo, F. Energ. Nucl. (Madrid), 10: 376-88(Sept.-Oct. 1966). (In Spanish).

The characteristics and construction of the "Nayade" radiation facility are described. The dosimetery methods used are outlined. (J.S.R.)

17759 SOURCE FLOAT ELEVATOR (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). (CAPE-1556).

4 drawings.

A water tank elevator or float device is described which is located in a tank in the recessed γ cell facility. The elevator is used in raising and lowering a 10,000 Ci cobalt-60 source and in providing desired strengths and patterns of the γ radiation. Automatic interlocks are provided which prevent raising the source elevator with the cell door open; opening the cell door when the elevator is raised; and opening the cell door or raising the elevator when the cell radiation monitor detects unsafe radiation levels within the cell. (For details see TID-4100, Suppl. 39.) (F.S.)

17760 QUICK DISCONNECT VACUUM COUPLINGS (Engineering Materials). (Stanford Linear Accelerator Center, Stanford Univ., Calif.). (CAPE-1551).

6 drawings.

Six in. and 10 in. disconnect couplings are described which are used to quickly and remotely disconnect or remove the Cherenkov detectors or other devices from the vacuum system of the Stanford Linear Accelerator. The couplings are located in the beam switchyard. (For details see TID-4100, Suppl. 39.) (F.S.)

17761 COMMUNICATION SATELLITE SYSTEMS TECHNOLOGY. A Collection of Technical Papers Drawn Mainly From the AIAA Communications Satellite Systems Conference, May 2-4, 1966, Subsequently Revised for this Volume. Marsten, Richard B. (ed.). Progress in Astronautics and Aeronautics. Volume 19. New York, Academic Press, 1966. 1068p. $12.00. (CONF-660517).

Fifty-two papers are presented on the technology of communication satellite systems and their present and future significance. An abstract of one paper appeared previously in NSA 20: 29608. The remaining papers deal with commercial point-to-point systems, military satellite communication systems, support subsystems and components, high-power systems, systems concepts, and a sociological overview of communication satellite systems. (L.C.L.)

17762 MAGNET COIL. (to U. S. Atomic Energy Commission). British Patent 1,060,346. Mar. 1, 1967. Priority date Sept. 11, 1964, United States.

The construction of a conductor used in a magnet coil in a spark chamber is described. The magnet coil has good cooling and current capacity and operates in a wide range of field and power levels. Copper tapes or strips replace hollow Cu tubes as the conductor and are used with spacing elements which accommodate coolant flowing over the strips. (F.S.)

17763 IMPROVEMENTS IN HEAT EXCHANGERS ADAPTED FOR GENERATION OF VAPOR FROM LIQUID. (to Babcock and Wilcox Co.). British Patent 1,060,220. Mar. 1, 1967. Priority date Feb. 28, 1963, United States.

A heat exchanger adapted for the generation of vapor from a liquid with a liquid metal such as Na, Bi, or NaK as the heating fluid is described. A double tube arrangement is used to provide annular flow space through which a third fluid passes. The third fluid is used as an intermediate heat transfer fluid and as a monitoring fluid to detect leakage of water or liquid metal. (F.S.)

17764 IMPROVEMENTS IN OR RELATING TO DISTILLATION OF WATER. Glueckauf, Eugen (to United Kingdom Atomic Energy Authority). British Patent 1,062,294. Mar. 22, 1967. Filed Feb. 17, 1965.

An improved process for desalination of seawater containing dissolved calcium sulfate is described. Desalination using low grade waste heat from a nuclear reactor for distillation is discussed. A vessel is provided which contains a bed of anhydrous calcium sulfate. Seawater heated to 113 to 167°C is passed through this bed removing the calcium sulfate as an anhydrite. The seawater is then distilled in flash distillation apparatus without calcium sulfate scale forming in the distillation apparatus. (F.S.)

17765 HYDRO-PNEUMATIC APPARATUS FOR CHANGING CRITICAL CONFIGURATION OF NUCLEAR FUEL MASS. Pollak, K. (to U. S. Atomic Energy Commission). U. S. Patent 3,288,682. Nov. 29, 1966.

A device for separating large nuclear fuel mass configurations in a safe, trouble-free manner in a short time to prevent fatal build-up of criticality is described. The masses, which are normally held adjacent, are separated by compressed gas containing a liquid body under pressure that is selectively and/or automatically released by pilot valves. The pilot valves are automatically actuated by dimensional expansion of the masses, and the valves act selectively or automatically independently in parallel to provide fluid stream division to prevent dump shock wave flow interference. (AEC)

17766 FLASH X-RAY GENERATOR (Engineering Materials). (Univ. of California, Livermore. Lawrence Radiation Lab.). (CAPE-1558).

31 drawings.

A flash x-ray generator producing a total exposure dose of 30 mR in 30 to 50 nsec is described. The generator is a three conductor coaxial transmission line consisting of the transmission line, a switch, and an evacuated electrode gap which is the x-ray tube. The operating cycle consists of charging the line to 50 kV and actuating the switch which must be remade for each pulse of x-rays. The length of the electron pulse is equal to twice the traveling wave transit time of the line. The x-ray pulse is limited to 50 nsec. A peak cathode current of 37,000 A and a peak voltage of 84 kV have been measured. (For details see TID-4100 Suppl. 39). (F.S.)

17767 ELECTROMAGNETIC PUMP EMPLOYING A THERMOELECTRIC CURRENT GENERATOR. (to North American Aviation, Inc.). British Patent 1,053,151. Dec. 30, 1966. Priority date Feb. 18, 1964, United States.

A thermoelectrically energized pump for pumping electrically conductive liquids such as liquid metals is described. The pump is useful for applications in remote locations and in space vehicles using nuclear reactor power systems. The pump is lightweight, compact in size, and reliable, withstanding shock and acceleration tests similar to those encountered in space vehicles. (F.S.)

17768 PROCESS FOR THE PRODUCTION OF A PRESTRESSED CONCRETE PRESSURE VESSEL FOR A NUCLEAR REACTOR. (to Siemens-Schukertwerke Aktiengesellschaft). British Patent 1,063,235. Mar. 30, 1967. Priority date Mar. 6, 1964, Germany.

A method is described for producing prestressed concrete cylindrical pressure vessels for nuclear reactors. The ends of the vessels are closed by end walls formed by frusto-conical blocks which are supported by a ring of wedge-shaped supporting elements. The frusto-conical blocks are positioned before the interior of the vessel is brought to its rated operating pressure. (F.S.)

17769 IONIZED AIR-PRODUCING DEVICE. Asahina, Jiro. British Patent 1,059,417. Feb. 22, 1967. Priority date Dec. 30, 1963, Japan.

A device for producing ionized air, including at least one ionizing radiation source composed of a mixture of synthetic resin with alpha or beta radiation sources, and a means of causing air to flow over the source is described. The device may be incorporated in an air conditioner, heating or cooling apparatus, or an electric fan. (B.G.D.)

Heat Transfer and Fluid Flow

Refer also to abstracts 17763, 19352, and 19451.

17770 (AECL-2591) TD-3: A G-20 COMPUTER PROGRAM. Kennedy, J. M.; Bain, F. E. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar. 1966. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $1.00.

TD-3 is a computer program for solving the time-independent heat conduction equation in three dimensions. The solution is obtained in a composite volume of different conducting materials. From the user's point of view the main feature of the program is the simplicity of preparing input data. TD-3 is written in APEX-IV, an ALGOL-like algebraic language. (auth)

17771 (AEEW-M-696) SCALING OF BURNOUT DATA FOR A SINGLE FLUID AT A FIXED PRESSURE. Kirby, G. J. (Atomic Energy Establishment, Winfrith (England)). Dec. 1966. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 3s. 6d.

The success of the scaling factor concept in linking burnout measurements made in two different fluids has previously been demonstrated. The possibility of linking measurements made on two different systems in the same fluid at the same pressure was investigated. Good accuracy may be obtained for systems whose linear dimensions differ by as much as a factor of two;

this offers the possibility of saving very substantial amounts of power in testing reactor fuel elements. A novel conclusion is that systems do not need to be geometrically similar in order to be linked by scaling factors. (UK)

17772 (AEEW-R-509) AN INVESTIGATION OF HEAT EXCHANGER FOULING IN DUST SUSPENSION COOLING SYSTEMS USING GRAPHITE POWDER AND CARBON DIOXIDE GAS. Garton, D. A.; Hawes, R. I.; Rose, P. W. (Atomic Energy Establishment, Winfrith (England)). 1966. 26p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 4s.

Experiments were performed to study the fouling of heat exchanger surfaces where heat is being transferred from a heated fluid to a cooled surface. The fluid studied was a suspension of 4 to 5 microns mean diameter graphite powder in carbon dioxide gas at near atmospheric pressures. The solids loading range covered was from 5 to 30 lb graphite/lb carbon dioxide, and gas Reynolds numbers were from 6000 to 16000. Temperature gradients of from 20 to 120°C across the cooler were obtained. The heat transfer ratio is correlated to show the dependence upon the solids loading ratio of the suspension, the gas Reynolds number and the temperature gradient across the cooler. The results demonstrated that stringent precautions are necessary to ensure complete dryness of the graphite powder and the loop flow surfaces before any useful quantitative fouling data can be obtained, as the presence of entrained moisture will accelerate the deposition of material on the cold walls of the heat exchanger and can result in plugging. The heat transfer coefficient showed no obvious dependency upon either the gas Reynolds number or the temperature gradient across the cooler over the range investigated. The measured heat transfer coefficient was considerably lower than that obtained when the heat is transferred from a hot wall to a cooler fluid. At a solids loading of 30 lb graphite/lb carbon dioxide, the heat transfer coefficient was only 50% of that for heat transfer from a heated wall. At solids loadings below 7 lb/lb, the heat transfer was less than that for a gas alone. (UK)

17773 (AEEW-R-511) MODEL FOR CORRELATING BURNOUT IN ROUND TUBES. Kirby, G. J. (Atomic Energy Establishment, Winfrith (England)). Sept. 1966. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 4s. 6d.

A model is presented which represents the film flow rate in the climbing film regime of boiling two-phase flow. By calculating the dryout point, burnout heat fluxes for round tubes both uniformly and non-uniformly heated axially have been predicted with accuracies as good as the best empirical correlations. The model is used to investigate the effect of varying flux profile. (UK)

17774 (BMwF-FBK-66-34) FESTSTOFFVERMISCHUNG IN GASDURCHSTROEMTEN WIRBELSCHICHTEN MIT KONTINUIERLICHEM FESTSTOFFDURCHSATZ. (Solids Mixing in Gas-Fluidized Beds with a Continuous Feed of Solids). Alfke, G.; Gaertner, E. (Technische Hochschule, Hanover (West Germany). Institut fuer Technische Chemie). Nov. 1966. 28p. (In German). Dep. mn.

The quantitative description of solids mixing in fluidized beds with continuous charge and discharge of the solid material is important for chemical engineering purposes. Therefore, residence time distributions of the solids were measured to calculate coefficients of axial solids mixing. The beds used in the study were 10 cm in dia and 8.5, 14.5, and 34.5 cm in height; sand of an average particle dia of 250 μm was fluidized with air. The mixing coefficients obtained increased with the rate of solids feeding and with the height of the bed; the fluidizing gas velocity did not influence the coefficients. Furthermore, the data indicated that fluidized beds have to be considered as heterogeneous systems with regard to solids mixing. (tr-auth)

17775 (GAMD-7346) RAT-3D: A GENERAL THREE-DIMENSIONAL HEAT TRANSFER CODE. Clark, Suzanne S.; Troost, M. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 10, 1966. Contract AT(04-3)-167. 227p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The RAT-3D program is a FORTRAN IV code for solving transient, three-dimensional heat transfer problems. The nonlinear-partial-differential heat transport equation has been rewritten as a set of quasilinear finite difference equations. This set of equations is solved by a mathematically stable alternating gradient method. Some special features are: anisotropic thermal conductivities, radiation across internal gaps, internal and external coolants, description of material properties as functions, and simple geometrical input. A small subroutine, LINK, is written in MAP. This subroutine is difficult to convert because it is compiler dependent. (auth)

17776 (RISO-135) GAS SEPARATION IN THE RANQUE-HILSCH VORTEX TUBE. MODEL CALCULATIONS BASED ON FLOW DATA. Linderstroem-Lang, C. U. (Danish Atomic Energy Commission, Risoe. Research Establishment). June 1966. 30p. Dep. mn.

In a previous publication a number of experimental data were presented, showing the gas-separation ability of a series of Ranque-Hilsch vortex tubes. It was concluded that the driving force behind the observed effects is the centrifugal field. This result is used for the calculation of the separation potential of the tubes from estimated tangential-velocity distributions. A simple model of the secondary flows in the tubes is shown to provide a basis for a quite accurate reproduction of most of the gas-separation results obtained previously. (auth)

17777 (RT-ING-(66)11) MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ. Rapporto di Avanzamento al 30 Giugno 1965. (Volumetric Fraction Measurement of Vapor by the γ Attenuation Method. Progress Report for June 30, 1965). Lupoli, P. (Comitato Nazionale per l'Energia Nucleaire, Rome (Italy)). 1966. 59p. (In Italian). Dep. mn.

Problems related to void fraction measurement by the γ-ray attenuation method are examined. The measuring circuit and measurement technique are described and a detailed analysis is made of the most important parameters which define the calibration curve and the errors. (tr-auth)

17778 (RT-ING-(66)12) MISURA DELLA FRAZIONE VOLUMETRICA DI VAPORE COL METODO DELL'ATTENUAZIONE γ. Rapporto di Avanzamento al 30 Settembre 1965. (Volumetric Fraction Measurement of Vapor by the γ Attenuation Method. Progress Report for September 30, 1965). Lupoli, P.; Festoso, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 59p. (In Italian). Dep. mn.

Results are presented of void fraction measurements by the γ-ray attenuation method in plexiglass models of rectangular and tubular channels. The best conditions of measurement are investigated and the analysis of errors is made for each test section. (tr-auth)

17779 PERFECT THERMODYNAMIC VAPOR CONCEPT AND APPLICATION TO THE ANALYSIS OF POWER CONVERSION CYCLES. Hammitt, A. G.; Cecil, R. A. (Thompson-Ramo-Wooldridge Inc., Redondo Beach, Calif.). J. Spacecraft Rockets, 4: 195-200(Feb. 1967).

A "perfect thermodynamic vapor" is postulated which may be considered to be the vapor analogy of a perfect gas. The thermodynamic properties of the vapor are derived and shown to compare favorably with a real vapor. The usefulness of the concept is demonstrated by deriving an analytic relation for the efficiency of two Rankine cycles of interest. (auth)

17780 THERMOPHYSICS AND TEMPERATURE CONTROL OF SPACECRAFT AND ENTRY VEHICLES. A Selection of Technical Papers based mainly on the American Institute of Aeronautics and Astronautics Thermophysics Specialist Conference held at Monterey, California, September 13-15, 1965. Heller, Gerhard B. (ed.). Progress in Astronautics and Aeronautics, Volume 18. New York, Academic Press, 1966. 884p. $9.75. (CONF-650955).

Forty-two papers on the thermophysics and temperature control of spacecraft and entry vehicles are presented. An abstract was prepared for one paper. Abstracts of five papers have appeared previously in NSA: see 20: 7653, 7654, 7655, 8454, and 23184. The remaining papers discuss thermal radiation properties of solids, effects of space environment on the optical properties of thermal control surfaces, physics of reentry, and spacecraft thermal modeling and design. (L.C.L.)

For an abstract of the individual paper see: 18536.

Isotope Technology

Refer also to abstract 17759.

17781 LOW-THRUST PROPULSION FOR THE MORL. Goodman, Milton (Douglas Aircraft Co. Inc., Santa Monica, Calif.). J. Spacecraft Rockets, 4: 183-7(Feb. 1967).

Resistojets, arcjets, ion engines, radioisotope thrusters, and catalytic monopropellant engines are compared for low-thrust propulsion systems for manned orbiting research laboratories of the Manned Orbital Research Laboratory (MORL) class. Descriptions, specifications, and stabilization and control requirements are given for the zero-g and artificial-g spin modes with solar cell and Brayton cycle power system configurations. Propellant resupply occurs every 90 days by use of an Apollo logistics vehicle. Liquid hydrogen, ammonia, and hydrazine are considered as propellants. (Another possibility is to use the CO_2, H_2, and H_2O evolved from the environmental control and life support cycle.)

The studies indicate that the drag-make-up and attitude-control functions previously performed by 50-lb thrust chemical engines, firing for a few seconds per orbit, can be accomplished with millipound-thrust engines used in nearly continuous operation in conjunction with control moment gyros. Liftoff, resupply, and 5-yr mission weight comparisons suggest that resistojets and radioisotope thrusters may afford weight savings for MORL-type missions. (auth)

17782 ISOTOPES AND RADIATION TECHNOLOGY. Volume 4, Number 1. Baker, P. S.; Lafferty, Robert H. Jr.; Gerrard, Martha; Fuccillo, D. A.; Greene, R. E.; McKinney, F. E.; Carden, Joan E.; Rupp, A. F. (eds.). Contract W-7405-eng-26. One of the five Quarterly Technical Progress Reviews published for the Division of Technical Information, USAEC. Oak Ridge, Tenn., Oak Ridge National Lab., Fall 1966. 76p. GPO $0.70 Domestic, $0.90 Foreign.

Twenty years of progress in radiation technology are reviewed with emphasis on the early history of radioisotope research and production and the agricultural, medical, and industrial uses of radioisotopes. Individual abstracts were prepared for 12 sections of this review. (L.C.L.)

For abstracts of individual papers see: 17783–17794.

17783 BRIEF HISTORY OF RADIATION AND ISOTOPES. Isotop. Radiat. Technol., 4: No. 1, 3-8(Fall 1966).

The history of radiation and isotopes from the discovery of x rays by Roentgen to the discovery of fission by Meitner and Frisch is briefly reviewed in this article. This review is divided into three parts: in the first, the discovery of radiation and radioactivity is described; in the second, the development of methods and techniques using isotopes is discussed; and in the third, artificial radioisotopes and nuclear fission are considered. For easy reference a chronology of these developments is included. (auth)

17784 RADIOACTIVE TRACERS AND THEIR APPLICATIONS. von Hevesy, Georg. Isotop. Radiat. Technol., 4: No. 1, 9-12(Fall 1966).

Observations on the uses of natural and artificial radioisotopes are made by the first scientist to apply both to plant and animal studies. The first activation analyses are described. (L.C.L.)

17785 EARLY WORK WITH RADIOISOTOPES. Seaborg, Glenn T. Isotop. Radiat. Technol., 4: No. 1, 13-20(Fall 1966).

The history of radioisotopes produced by cyclotrons and reactors for use in medical and biological research is reviewed. Examples of the early applications of tracer techniques in medicine, agriculture, biology, and industry are given. The magnitude of current radioisotope production and its importance is described. (L.C.L.)

17786 SOME EARLY STUDIES WITH THE PRODUCTS OF NUCLEAR PHYSICS. Lawrence, John H. (Univ. of California, Berkeley). Isotop. Radiat. Technol., 4: No. 1, 21-4(Fall 1966).

Examples of early research in the uses of radioisotopes in the biological and medical sciences are given. This work indicated the important role to be played by radioisotopes in advancing knowledge in these fields. Advances made due to the development of scintillation crystal radiation counters are described. The 30 years of progress in tracer techniques for medical diagnosis and treatment and for basic research in the life sciences points to unlimited applications in the future. (L.C.L.)

17787 EARLY HISTORY OF RADIOISOTOPES FROM REACTORS. Bizzell, Oscar M. (Atomic Energy Commission, Washington, D. C.). Isotop. Radiat. Technol., 4: No. 1, 25-32 (Fall 1966).

The historic and scientific events related to the first shipment of reactor-produced radioisotopes for peaceful uses, mainly medical research, are described. Details are given of the production of radioisotopes in Oak Ridge in 1946, the agencies and personnel involved, the demand from consumers, safety requirements and licensing, and the variety and quantity of radioisotopes used during that first year. (L.C.L.)

17788 EARLY DAYS OF THE RADIOISOTOPE PRODUCTION PROGRAM. Rupp, A. F.; Beauchamp. E. E. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 4: No. 1, 33-40(Fall 1966).

The early days of the radioisotope production program at the Oak Ridge National Laboratory and coordinated work at Argonne National Laboratory and Hanford are discussed. Developments in large scale production methods, remote handling techniques, and the use of fission products are described. (L.C.L.)

17789 EARLY HISTORY OF RADIOISOTOPE RESEARCH AND DEVELOPMENT IN THE CHEMISTRY DIVISION AT OAK RIDGE. Boyd, G. E. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 4: No. 1, 41-5(Fall 1966).

The early history of and personnel involved in radioisotope research and development at Oak Ridge are described briefly. Three methods for obtaining radioisotopes were studied; separation from reactor-irradiated elements, work on rare-earth separations with ion-exchange columns, and the preparation of high-specific-activity isotopes based on the use of the Szilard–Chalmers reaction in chain-reacting piles. (L.C.L.)

17790 RADIOISOTOPE CHARACTERISTICS, MEASUREMENTS, AND STANDARDS. Reynolds, S. A. (Oak Ridge National Lab., Tenn.). Isotop. Radiat. Technol., 4: No. 1, 46-52 (Fall 1966).

The development of techniques and standards for measuring the characteristics, such as half-lives and gamma intensities, of radioisotopes is surveyed. The improvement in accuracy and precision of nuclear measurements is described. The knowledge and methods of today are contrasted with those of 20 years ago. (L.C.L.)

17791 EARLY DEVELOPMENTS IN THE USE OF RADIOISOTOPES IN AGRICULTURE. Comar, C. L. (Cornell Univ., Ithaca, N. Y.). Isotop. Radiat. Technol., 4: No. 1, 53-8(Fall 1966).

The early developments in the uses of radioisotopes in agriculture are described. These uses, particularly for research studies in plants, animals, soils, waters, and insects, have expanded enormously from the late 1940's to the present. The broad variety of radioisotopes available today, the sophistication of the instrumentation and equipment, and the background of scientific information obtainable, point to the widespread use of nuclear energy techniques in biological and agricultural research. (L.C.L.)

17792 RADIOISOTOPES IN MEDICINE IMMEDIATELY AFTER THE GREAT 1946 DELIVERANCE. Brucer, Marshall. Isotop. Radiat. Technol., 4: No. 1, 59-62(Fall 1966).

Myths about the medical significance of the first shipment of radioisotopes are discussed. It was concluded that the first ten years of using radioisotopes for medical research did have the "astounding" effect of reawakening physicians to the relative importance of chemistry and physics in clinical medicine. (L.C.L.)

17793 EARLY USE OF RADIOISOTOPES AS TRACERS IN THE PETROLEUM INDUSTRY. Fries, Bernard A. (Standard Oil of California's Chevron Research Corp., Richmond). Isotop. Radiat. Technol., 4: No. 1, 63-5(Fall 1966).

The early uses of radioisotopes in the petroleum industry are described. These included tracer techniques for determining pipe line fluid interface location, corrosion of wells, study of distillation processes, and machine parts wear measurements. Examples of these applications are given. (L.C.L.)

17794 TWENTY YEARS OF RADIOISOTOPES. Isotop. Radiat. Technol., 4: No. 1, 66-8(Fall 1966).

The production of radioisotopes at ORNL from 1946 through 1965 is presented graphically. Individual graphs in terms of curies and dollar values are shown for ^{131}I, ^{90}Sr, ^{32}P, ^{14}C, ^{60}Co, and ^{137}Cs. The total number of shipments per year, total curies per year, and number of licensees per year are also given. (L.C.L.)

17795 APPARATUS FOR SHIELDING AND EXPOSING A RADIOACTIVE SOURCE. Corfa, Yves; Jossoud, Michel; Pelegrin, Pierre; Vertut, Jean (to Commissariat a l'Energie Atomique). British Patent 1,063,726. Mar. 30, 1967. Priority date Apr.7, 1964, France.

An apparatus is described which is used in an irradiation facility for shielding and exposing the radiation source when the substance to be irradiated moves as a screen or curtain between or around the source. A control system provides the required level of irradiation needed. Conduits are provided to bring the material to be irradiated from storage, move it past the source, and return it to storage. (F.S.)

17796 VAPOR FEED SYSTEM FOR EASY VAPORIZABLE MATERIALS TO THE ARC CHAMBER OF CALUTRONS. Bell, W. A. Jr.; Ennis, R. M. Jr. (to U. S. Atomic Energy Commission). U. S. Patent 3,313,935. Apr. 11, 1967.

A vapor feed system for easily vaporizable materials to the arc chamber of calutrons is described. A small length of restrictive tubing is provided between a heated charge bottle and an adjustable leak or needle valve, and a larger diameter tubing is provided between the valve and arc chamber, such that the charge vapor has its lowest conductance without allowing laminar flow between the charge bottle and the needle valve and a high Knudsen flow conductance between the valve and arc chamber, thus providing constant vapor flow at any desired value within a pressure range from 75 to 3000 microns and without restrictive condensation of feed material in the tubings. (AEC)

17797 ISOTOPE RECEIVER FOR A CALUTRON HAVING AN OIL RESERVOIR IN ITS COLLECTION POCKET. Bell, W. A. Jr.; Veach, A. M. (to U. S. Atomic Energy Commission). U. S. Patent 3,312,849. Apr. 4, 1967.

An improved calutron isotope receiver for achieving higher purity collection of low abundance isotopes, and/or isotopes of elements of high vapor pressure is described. The receiver is provided with a cooled collection pocket positioned well behind the defining face plate of the receiver, and cooled baffles are positioned between the face plate and the recessed pocket and above and below the ion beam path for stopping high-energy neutrals and low-energy ions. Also, further improvement in collected isotope purity is achieved by the use of oil placed in an oil reservoir in the recessed pocket and positioned such that a small portion of the ion beam strikes the oil in the reservoir to effect vaporization of the oil and deposition of the resulting vapor on the cooled ion collecting surface of the recessed pocket, thus permitting trapping of energetic ions thereon while at the same time preventing condensation and entrapment of neutral vapors by the collecting surface. (AEC)

Materials Testing

Refer also to abstract 17562.

17798 (BNWL-SA-97) HIGH VOLUME NONDESTRUCTIVE TEST APPLICATIONS AT THE HANFORD ATOMIC PRODUCTS OPERATION. Worlton, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Mar. 11, 1965. Contract AT-(45-1)-1830. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Nondestructive methods for inspection of thin wall tubing and the automatic inspection of nuclear fuel are described. Eddy current tests are used for the inspection of installed tubing, and ultrasonic tests are used for the inspection of as-fabricated tubing. Tubing test data for Zircaloy, stainless steel, and aluminum materials are tabulated. Automatic features of the equipment for fuel testing are stressed rather than the physics of the tests themselves. The integrity of Hanford production fuel elements is tested on a routine, production line basis. (P.C.H.)

17799 (NASA-TT-F-284) DYNAMICS AND STRENGTH OF SHELLS. Ogibalov, P. M. Translation of Voprosy Dinamiki i Ustoichivosti Obolochek, Izdatel'stvo, Moskovskogo Universiteta, 1963. 325p. (TT-65-50118). CFSTI $3.00 cy, $0.65 mn.

Fundamental information on the dynamics and strength of shells is presented. The theory of elasticity and plasticity as applied to thin-walled curved surfaces is given for many dynamic conditions. Classic strength of materials studies is applied to the calculation of stresses and strains in shells under these conditions. (L.C.L.)

17800 RADIATION SAFETY IN RADIOGRAPHY. Heffan, Howard (Naval Weapons Station, Concord, Calif.). Mater. Eval., 25: 83-90(Apr. 1967).

A general review of the methods and criteria for establishing radiation safety procedures in industrial x-ray and gamma-ray radiography programs is presented. The use and importance of the hazards analysis is discussed in relation to three types of installations, and the current thinking regarding the health of radiation workers and the Maximum Permissible Dose are reviewed. (auth)

17801 NONDESTRUCTIVE TESTING OF MACROSCOPIC OBJECTS USING NEUTRONS. Barton, John Penrose (to Univ. of Birmingham). British Patent 1,063,561. Mar. 30, 1967. Filed Jan. 22, 1963.

A nondestructive method including equipment used in obtaining a representation of the interior of a macroscopic body which contains H is described. An incident beam of monochromatic neutrons in the epithermal energy range is directed at the body. The neutrons transmitted by the body comprise unscattered neutrons having an energy level substantially equal to the energy level of the incident beam. The unscattered neutrons are passed to a defector system sensitive to neutrons of the energy range of the incident beam. The equipment used consists of a neutron source, velocity selector, and a detector system. (F.S.)

17802 METALLOGRAPHIC TEST STAND (Engineering Materials). (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). (CAPE-1480).

7 drawings.

A servocontrolled apparatus is described which is used for low-cycle fatigue tests at elevated temperatures up to 1000°C. Round specimens are subjected to programmed cyclic loading in the axial direction. Heating of the specimen is by induction. Tests may be performed with control of either load, strain, or table position. (For details see TID-4100 Suppl. 39). (F.S.)

Protective Structures

Refer also to abstract 17907.

17803 (AD-636048) ENTRANCEWAYS AND EXITS FOR BLAST-RESISTANT FULLY-BURIED PERSONNEL SHELTERS. Final Report. Stevenson, J. D.; Havers, J. A. (IIT Research Inst., Chicago, Ill.). Sept. 1965. Contract OCD-PS-64-50. 335p. CFSTI $3.00 cy, $0.65 mn.

The work reported in this study is a continuation of the Total Shelter Design Optimization series which is currently in progress. These studies have developed the design requirements and identified in-place costs for single-purpose, fully buried personnel shelters of 100-, 500-, and 1000-man capacities. The attack environment, for analytical purposes, is described by a megaton yield (W = 1 to 100 Mt) nuclear explosion and by side-on surface overpressures of 10 to 200 psi. In the two earlier studies of this series, structural design and cost data were developed for fully buried personnel shelters of 100-, 500-, and 1000-man capacities. These related studies supplied the in-place structural cost for each shelter capacity as a function of the design over-pressure, but did not include any detailed consideration of suitable entranceways to serve the shelters. The scope of the earlier studies is extended by investigating the design requirements and structural costs for shelter entranceways. (auth)

17804 (NP-16553) METHODS OF SHELTER COST ANALYSIS. Final Report. Barksdale, Byrd H. Jr.; Wade, Samuel R. (Hayes, Seay, Mattern and Mattern, Roanoke, Va.). Feb. 1967. Contract OCD-PS-65-151. 76p.

Computer methods of determining immediate and long-term total cost of shelters incorporated within a building at a preliminary design stage were studied. All cost items comprising total cost were investigated and analyzed. It was concluded that many of the items comprising long-term total cost were indeterminate to such a degree that computer methods of analysis would not produce defensible estimates. To develop a method of shelter cost analysis, at a preliminary design stage, will require development of standards and design logic to analyze the effects of changes in building geometry and components to provide protection against effects of nuclear weapons. These factors, which may be identified, influence costs and a program may be developed to account for the factors in producing estimates. Once these data are developed, and with the application an In-Place Unit Method of cost estimating, realistic immediate alternative shelter cost estimates may be produced. It is believed that development and implementation of these techniques would make it practical to quickly assess protection factors and the impact of cost of changes in geometry, mass, aperture, lighting and ventilation. Probably one of the most useful applications would be in sensitivity analysis of several alternatives to determine optimum shelter cost. (auth)

Radioactive Material Handling

17805 (BNWL-338) VOLATILIZATION OF FISSION PRODUCTS FROM HIGH LEVEL CERAMIC WASTES. Albrethsen, A. E.; Schwendiman, L. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Volatilization has been established as the predominant mechanism of fission product release from simulated high level ceramic wastes when exposed to high temperatures. The volatility of cesium appears consistent and independent of ceramic composition when the ceramic is molten. The rate—about 1%/hr from a sample 1 cm thick—indicates the probability of diffusion control. Volatility of ruthenium is erratic and probably due to incomplete deoxidation of the ceramic. The releases of ^{90}Sr and ^{144}Ce were one thousandth or less than the rate of cesium release. (auth)

17806 (HW-63121) LABORATORY STUDIES OF HANFORD WASTE CRIBS. Reisenauer, A. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Nov. 24, 1959. Contract AT(45-1)-1350. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Laboratory research on the fixation and retention of radioactive materials on soils was undertaken for application to the ground disposal of low- and intermediate-level waste solutions from Hanford chemical separations plants. Tabulation of pertinent laboratory data on Hanford waste cribs is presented. The results of the research permit the estimation of waste volumes which would produce a limited breakthrough of long-lived nuclides into the ground water for a given crib and type of waste. (L.C.L.)

17807 SOLVING THE WASTE-DISPOSAL PROBLEM. Blanco, R. E.; Blomeke, J. O.; Roberts, J. T. (Oak Ridge National Lab., Tenn.). Nucleonics, 25: No. 2, 58-61; 68(Feb. 1967).

The storage of high-level radioactive liquid wastes is discussed with emphasis on safety and economy. The immediate conversion of liquid waste to glassy microcrystalline solids and the ultimate storage in a dry environment such as a salt mine are recommended. The advantages of solidified waste are low bulk, low solubility, safety, and low cost. The magnitude of the waste disposal problem by the year 2000 is described. (L.C.L.)

17808 STORAGE TANKS FOR LIQUIDS. Williams, Norman Elliott; Higginson, Walter (to United Kingdom Atomic Energy Authority). British Patent 1,063,388. Mar. 30, 1967. Filed Sept. 23, 1963.

A tank for the long-term storage of liquids containing concentrated radioactive solid materials in suspension is described. A submerged air or liquid jet system is provided in the tank causing currents to radiate over the floor of the tank to agitate deposited sediments. Heat from decay of radioisotopes is distributed over the contents of the tank which prevents local hot spots. (F.S.)

17809 EVAPORATING SYSTEM HAVING LEVEL CONTROL. Auchapt, Pierre; Jacquotte, Max; Sautray, Roger (to Commissariat a l'Energie Atomique). British Patent 1,063,195. Mar. 30, 1967. Priority date Aug. 28, 1964, France.

An evaporating system capable of concentrating radioactive solutions is described. The system consists of a boiler connected to a liquid vapor separator. Level control is provided by two connected vessels, one of which is connected to the boiler and separator and the other is only connected to the separator. The vessels are interconnected by a siphon and level control is achieved by the operation of the basic laws governing the balance of fluids. Mechanical valves are not used thus avoiding valve maintenance and replacement. (F.S.)

17810 CONCENTRATION OF SOLUTIONS CONTAINING RADIOACTIVE MATERIALS BY EVAPORATION. Goeldner, Richard Warren (to Aqua-Chem, Inc.). British Patent 1,063,533. Mar. 30, 1967. Filed May 17, 1965.

A method for concentrating radioactive materials by evaporation from a waste solution such as a reactor coolant stream is described. In addition to the concentration of radioactive waste, B compounds may be separated from the liquid. The method is used to produce a liquid product of lower radioactivity from a feed material of higher radioactivity. The former may be returned to the reactor coolant system for reuse and the latter disposed of. (F.S.)

Vacuum Engineering

17811 (WERL-2823-24) ULTRAHIGH VACUUM TECHNIQUES. Semiannual Report, June 1-November 30, 1966. Fraunfelder, R.; Lange, W. J.; Singleton, J. H. (Westinghouse Research Labs., Pittsburgh, Pa.). Contract AT(30-1)-2823. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the independent determination of the permeation, solubility, and diffusion constants of hydrogen in tungsten and on the replacement of one adsorbed gas by a second gas from the gas phase. Measurements were also made on the nitrogen-tungsten and nitrogen-molybdenum systems. No measurable replacement was observed for the hydrogen-nitrogen system on tungsten in the study of gas replacement. (F.S.)

17812 PRESSURE GAGE WITH EXTERNAL COLLECTOR FOR VERY LOW PRESSURES. Groszkowski, J. (Technical Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 14: 1023-31(1966). (In French).

The results of studies on the probe of the ionization pressure gage of the Bayard-Alpert type are reported. A new probe for the gage, with reduced sensitivity to x radiation, which works without magnetic field and modulation was developed and constructed. This probe, analogous to that of the Bayard-Alpert probe, consists of cathode and cylindrical gauze anode, one wall of which is spiral and the other has a pierced disc. The collector is placed opposite this orifice. A diagram of the new pressure gage and a tabulation of its electrical characteristics are given. (J.S.R.)

17813 A FAST IDENTIFICATION OF TRACES OF SILICON BY ACTIVATION ANALYSIS WITH 14 MeV NEUTRONS. Eden, Y. (Soreq Nuclear Research Center, Yavne, Israel). Nucl. Instrum. Methods, 49: 352-4(1967).

Activation analysis is used for the identification of traces of silicon in some vacuum pump oils. The detection of silicon is based on the nuclear reaction $^{28}Si(n,p)^{28}Al$ induced by 14 MeV neutrons from a neutron generator. The 1.78 MeV γ-ray emitted by the ^{28}Al is measured, and the decay of the radioactivity (half-life = 2.3 min) is followed. The sensitivity of detection was 6 μg. (auth)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 18502, 19152, 19280, and 19296.

17814 (AECL–2637) APPLICATION OF SOLID STATE AMPLIFYING RADIATION DETECTORS IN HEALTH PHYSICS. Jones, A. R. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 20p. Dep. mn. CFSTI $3.00 cy, $0.50 mn. AECL $0.50.

To assess amplifying radiation detectors for use in health physics, measurements were made on five samples. The properties measured were: dependence of noise on applied voltage, gain on applied voltage, sensitivity of gamma rays on energy, sensitivity to gamma rays on voltage, and sensitivity to gamma rays on temperature. The results of these measurements are presented and suggest that the detectors would be suitable for measuring exposures, or doses, and their rates over a wide range of energies (0.03-1.25 MeV) and over a wide range of exposure rates (background up to ~1000 Roentgens/hour). (auth)

17815 (AECL–2657) MEASUREMENT OF NEUTRON FLUENCE BY FISSION FRAGMENT DAMAGE TRACK DETECTION. Bhatt, R. C. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug. 1966. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $1.00.

The phenomenon of fission-fragment damage produced in glass and mica was studied for its possible application in the measurement of neutron fluence. Experiments with three detector systems employing natural uranium foil in conjunction with mica, phosphate glass and silicate glass, are described. The thermal neutron sensitivity of each of the above systems is estimated from standardization experiments with thermal neutrons. Neutron sensitivities of a number of detector systems at various neutron energies of interest are predicted with the help of corresponding fission cross-section data. Applications to personnel neutron dosimetry are discussed. (auth)

17816 (AERE-M–1830) DETECTION OF HIGH BETA-RAY DOSE RATES WITH A SIMPLE DETECTOR. Burt, A. K.; Gibson, J. A. B. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1967. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 1s. 9d.

A simple instrument was developed to measure beta-ray dose rates above 1 rad/h (in tissue) and contamination levels greater than 0.04 nCi/cm^2. This detector was used in contamination control of high activity handling cells. The rate of energy deposition (dE/dx) is measured in 0.010 inch of plastic phosphor (NE 102A) with a simple photodiode to detect the light output. The instrument was also used to determine surface activity by using a plastic collimator to define a fixed area for measurement. The range of the instrument is from 2 to at least 25,000 rad/h (in tissue). The gamma-ray response is small below 100 R/h and is a linear function of dose rate above this level. The instrument is essentially tissue equivalent (±20%) above about 0.15 MeV (electron energy). (auth)

17817 (CSIR-253) COINCIDENCE STANDARDIZATION OF ELECTRON-CAPTURE NUCLIDES UTILIZING A 4 π-INTERNAL LIQUID SCINTILLATION COUNTER. Steyn, J. (Council for Scientific and Industrial Research, Pretoria (South Africa). National Physical Research Lab.). 1967. 12p. Dep. mn.

The use of a 4π-liquid scintillation counter in a coincidence arrangement with a gamma scintillation detector for the standardization of electron-capture nuclides is described. Results of counting measurements on the nuclide cobalt-57 are given, which show that a remarkable degree of reproducibility of counting efficiency is obtained with the liquid scintillation counter. (auth)

17818 (INR–739/XIX/D) DIFFERENTSIAL'NAYA REKOMBINATSIONNAYA KAMERA. (Differential Recombination Chamber). Zel'chinskii, M.; Kharnovetskii, K. (Institute of Nuclear Research, Warsaw (Poland)). July 1966. 18p. (In Russian). Dep. mn.

The form of the volt-ampere characteristics of an ionization chamber often depends on the linear energy loss of the particle producing the ionization. This dependence is used in recombination chambers in order to determine the factor of merit or the Q-factor of mixed radiation. The ratio of the current at a definite voltage of the applied electric field to the saturation current can serve as a measure of the Q-factor which is ordinarily used in determining the dose equivalent. It is convenient to determine the dose directly with a system of three plane electrodes. A central measuring electrode 3 has electrodes 1 and 2 on each side of electrode 3. A sufficiently high voltage is applied to electrode 1 so as to obtain a saturation current in the space between electrodes 1 and 3, where the current is proportional to the dose rate. The voltage applied to electrode 2 is selected in such a manner that the decrease in efficiency of ion collection in the space between electrodes 2 and 3 is linear with increasing Q-factor of the mixed radiation. The difference current is proportional to the product of the dose times the Q-factor. A chamber is designed with 25 electrodes having an electrode thickness of 3 mm and a distance between electrodes of 7 mm. The operating gas pressure is ~1 atm. The chamber is calibrated with two sources of radiation: ^{60}Co (Q-factor = 1) and a Po–Be neutron source (Q-factor = 7.3). The accuracy of determining the dose equivalent of mixed radiation of unknown origin is ~20%. The maximum dose rate to be measured is 10 rads/hr. (TTT)

17819 (ORNL-TM–1768) SUMMARY REPORT ON CIVIL DEFENSE RADIOLOGICAL INSTRUMENT DEVELOPMENT, 1961 TO 1966. Russell, J. A. Jr. (comp.) (Oak Ridge National Lab., Tenn.). Mar. 1, 1967. Contract W-7405-eng-26. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

ORNL provided technical assistance to the Office of Civil Defense on specialized instrumentation. Two instruments were developed and a number of tests were performed leading to the improvement of existing instrument designs. ORNL assistance to June 30, 1966 is described. (auth)

17820 (UCRL–13272) FURTHER DEVELOPMENT OF SEMICONDUCTOR DETECTORS FOR GAMMA TRANSIENT DETECTION. Final Report. (Solid State Radiations, Inc., Los Angeles, Calif.). [nd]. Contract W-7405-eng-48. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For California Univ., Livermore. Lawrence Radiation Lab.

The fabrication of semiconductor detectors for gamma transient detection is discussed. Germanium, gold-doped silicon, gallium arsenide, as well as silicon diodes were fabricated and evaluated. Methods of optical dry running of semiconductors were investigated and a pulsed xenon flash lamp was designed for field use. Finally, prototype silicon diodes suitable for application in a high-vacuum photodiode were designed and fabricated. (B.G.D.)

17821 (UJV-1546) ZVYSENI DETEKCNI UCINNOSTI PRI POUZITI SIRY JAKO DETEKTORU RYCHLYCH NEUTRONU. (Improved Detection Efficiency in Use of Sulfur as a Fast Neutron Detector). Kadlec, V.; Otopal, P. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1966. 29p. (In Czech). DTIE.

In studies on the irradiation of ^{32}S under various conditions, the dependence of the amount of ^{32}P produced on the flux was verified. Separation of the ^{32}P from irradiated sulfur used as a fast-neutron detector was concluded to be a very accurate and simple procedure for increasing the detector sensitivity by a factor of 4. A flux of 5×10^3 fast neutrons/cm^2 sec can be measured. Reproducibility of the results was good under all irradiation conditions studied. The distribution of ^{32}P between the sides and bottom of the container depended on the irradiation conditions, but the total ^{32}P depended on the flux. The maximum irradiation temperature that can be used is 380°C. At higher temperatures burnup is complete; at lower temperatures there is an inactive residue. (TTT)

17822 (AEC-tr–6709) HANDBOOK OF RECORDING INSTRUMENTS FOR IONIZING RADIATION. Egorov, I. M.; Lazarev, A. F.; Perov, N. L.; Timofeev, A. A.; Zhernov, V. S. (comps.). Translation of Apparatura Dlya Registratsii Issledovaniya Ioniziruyushchikh Izluchenii, Atomizdat, Moscow, 1965. 468p. (IPST-Cat.–1800). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $23.50 fs, $10.21 mf.

The handbook describes mass-produced and experimental Soviet equipment devices, installations photomultipliers, scintillators, Geiger–Mueller counters and ionization chambers. It contains characteristics of devices used for personnel dosimetry, dose and dose rate measurements, monitoring the radioactive contamination of work surfaces and water, aerosol instruments, single-channel and multichannel analyzers. (B.G.D.)

17823 (ORNL-tr–1520) DETERMINATION OF FAST NEUTRON SPECTRA WITH THRESHOLD DETECTORS. Stiller, G. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH–1016. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The discussion of determining fast neutron spectra with threshold detectors includes the procedure for the determination of the spectrum, covering the use of reaction thresholds, the use of ef-

fective thresholds according to the method of Grundl and Usner, and the polygonal method, the calibration of the threshold detectors, and the application of the method of reaction thresholds and the Gundl and Usner method in a shielding experiment. (J.F.P.)

17824 (ORNL-tr-1521) DETERMINATION OF THE FAST NEUTRON FLUX SPECTRUM WITH THRESHOLD DETECTORS. Stiller, G. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1016a. 14p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

Supplement to ABS-THH-1016.

The discussion of determining the fast neutron flux spectrum with threshold detectors covers the determination of the stepped flux by iteration, application of the polygon method with consideration of the effective thresholds according to Grundl and Usner, and the application of the polygon method with consideration of the reaction thresholds including determination of the integrals $\int_E^{E+1} \sigma(E)EdE$, and an application of the method in a shielding experiment. (J.F.P.)

17825 SEMICONDUCTOR DETECTORS FOR IONIZING RADIATION. Hofker, W. K. (Philips Research Labs., Amsterdam). Philips Tech. Rev., 27: 323-36(1966).

Germanium and silicon counters with p-n and p-i-n configurations are extremely useful for detecting and measuring the energy of gamma quanta and high-energy charged particles. Except with very heavy particles, these semiconductor detectors are highly linear and have a particularly high resolution (about 20 keV for α-radiation, only a few keV for β- and γ-radiation). The pulse height depends only on the quantum energy (particle energy) E and not on the nature of the radiation. With extremely thin detectors it is also possible to measure dE/dx and thus identify unknown heavy particles. The construction of the device is readily adaptable to specific requirements; to measure directional distributions, for example, a detector can be divided into numerous subdetectors (checker-board counter). The resolution is higher for larger values of the charge carrier life compared with the transit time in the counter, and for lower bias current. A p-i-n detector combines a large detection volume with a weak bias current. (auth)

17826 NOTE ON DATA ANALYSIS FOR STREAMER TRACK CHAMBERS. Fries, D. E. C. (Stanford Linear Accelerator Center, Calif.). Z. Naturforsch., 21a: 1787-91(1966).

The analysis of streamer track chamber data can be performed using parts of the available bubble chamber analysis procedures with the exception of the geometrical part. Here major modifications are required in order to fit particle tracks to unmeasured vertices and to account for nonuniform magnetic fields. A method and its test, which is suited to handle these particular problems, is described. (auth)

17827 COMPUTER CONTROLLED PRECISION FILM SCANNER. Bordner, C. A.; Brenner, A. E.; de Bruyne, P. (Harvard Univ., Cambridge, Mass.). Radio Electron. Eng., 33: 171-6 (Mar. 1967).

A flying-spot film scanner was developed, capable of a short sweep in any direction from any of the 1024 × 1024 precise positions on the face of a 5-inch cathode ray tube. The spot is imaged on a film with 1:1 optics. Fine black lines on the film can be located with an accuracy of about 3 μm. The width and degree of blackness of these are recorded and the data are transferred to a computer on demand. The computer processes the data and provides fresh instructions for the scanner so that the following sweep vector can be optimally specified. The scanner is particularly applicable in high energy physics experiments. (UK)

17828 EFFECTS OF OXIDATION ON SURFACE-BARRIER DETECTORS. Chisaka, Haruo (Tokyo Metropolitan Isotope Research Center); Morita, Eiichi; Takeda, Shigeru; Masuda, Masayoshi. Jap. J. Appl. Phys., 6: 542-3(1967).

An investigation was undertaken in order to find the best surface treatment for surface barrier detectors. The leakage current, noises, and photoresponses were measured for various surface treatment and a correlation between these factors was also investigated. (B.G.D.)

17829 CsI(Na) SCINTILLATION CRYSTALS. Breiter, G.; Schulz, G. (Univ., Heidelberg). Phys. Lett., 24A: 331-2 (Mar. 13, 1967).

The light output of CsI(Na) scintillation crystals shows a maximum at 0.01 mol % sodium. Optimum growing conditions for crystals with this concentration are indicated. (auth)

17830 TIME-OF-FLIGHT ELECTRON VELOCITY SPECTROMETER. Baldwin, G. C.; Friedman, S. I. (General Electric Co., Schenectady, N. Y.). Rev. Sci. Instrum., 38: 519-31 (Apr. 1967).

A velocity selector is described which is designed for measurement of the total collision cross section of electrons in the energy region below 1 V. The system determines the distributions of times of flight of single electrons over a measured path at selected pressures of a specimen gas. The electrons are generated by repetitive illumination of a photoemitter by a spark gap, pass over a shielded drift path, enter an accelerating field, and impinge on an electron multiplier. Electronic equipment and data reduction for analysis of time-of-flight and amplitude distributions of electron counts are described; data illustrative of performance are presented, including typical transmission measurements in helium and argon which extend to 150 mV. (auth)

17831 NOVEL LITHIUM DRIFT CONTROL METHOD FOR SILICON AND GERMANIUM RADIATION DETECTORS. Schueler, W. A. (Oak Ridge Technical Enterprises Corp., Tenn.). Rev. Sci. Instrum., 38: 539-41(Apr. 1967).

A method and an apparatus are described which allow a nondestructive indication of the progress of the drifting operation. While drifting, pulsed light is shone onto the face opposite the lithium diffused layer of the device. The photosensitivity of the detector is used to obtain a signal whose amplitude is inversely proportional to the window thickness, i.e., the thickness of the undrifted region. A charge sensitive amplifier and a peak rectifier convert the pulses into a dc signal which is used for window thickness indication. (auth)

17832 RISE TIME IN SOLID-STATE DETECTORS. Alberigi Quaranta, A. (Univ., Bologna). Nuovo Cimento (1), 4: Suppl., 631-46(1966).

The research performed on various factors effecting the rise time of semiconductor detectors is reviewed. The topics discussed are the equivalent circuit, plasma time, and charge-collecting time in semiconductor detectors. Applications to the physics of semiconductors are also considered. (J.F.P.)

17833 RECENT METHODS OF STUDYING E. A. S. Castagnoli, C.; Dardo, M.; Penengo, P. (Istituto di Fisica Generale, Turin). Nuovo Cimento (1), 4: Suppl., 647-64(1966). (In Italian).

In the study of extensive atmospheric showers (E.A.S.), the method developed has followed two lines of attack: extension of the surface of conventional detectors and the development of new detection methods based on new physical characteristics of the E.A.S. which make possible a substantial increase of the correction area. Some methods proposed or developed in this last direction are reviewed. These include detection of E.A.S. in Cherenkov light, photography of E.A.S. in Cherenkov light with brilliant intensifiers, and detection of E.A.S. in fluorescent light. (J.S.R.)

17834 NOMOGRAM FOR MINIMIZING THE RELATIVE STATISTICAL ERROR OF NORMALIZED COUNTING RATES. Winkler, K. (Institut fuer Physikalische Chemie, Berlin). Kernenergie, 9: 384-9(Dec. 1966). (In German).

The function of variable normalized counting rates essential for radiometric investigations of kinetic processes $f = (I_\infty - I)/(I_\infty - I_0)$ (I_∞—standard counting rate, I—counting rate variable during the process in consideration, I_0—background counting rate) has a minimum relative statistical error $\sigma_{rel} = \Delta f/f$ for the given total time of measurement $T = kt_\infty + lt_0$ (t_∞, t_0 being the periods of measuring the standard and background counting rate, respectively; k, l—coefficients). The general solution of error function fulfilling the minimum condition was improved. A nomogram allows determination of unknown parameters of measurement for a given permissible deviation from minimum value or for a strong minimum. (auth)

17835 LARGE PERMANENT MAGNET SEMICIRCULAR BETA RAY SPECTROGRAPH. Kormicki, Jan; Niewodniczanski, Henryk; Stachura, Zbigniew (Inst. of Nuclear Physics, Krakow). Nukleonika, 11: 755-76(1966).

A large permanent magnet semicircular beta ray spectrograph with maximum radius of the electron path = 420 mm is described. The dimensions of the pole pieces are 1000 × 630 mm^2. The gap height is 60 mm. Detection of electrons occurs on photographic plate or by using G—M counters. Energy resolution is about 0.04%. A brief description of the applied method is given. Examples of the use of the spectrograph are presented. (auth)

17836 SEMICONDUCTOR SPECTROMETERS OF PENETRATING NUCLEAR RADIATIONS DEVELOPED IN THE INSTITUTE OF NUCLEAR RESEARCH. Chwaszczewska, Janina; Dakowski, Miroslaw; Przyborski, Wincenty; Sowinski, Mieczyslaw; Stegner, Adolf (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 11: 703-12(1966).

The semiconductor spectrometers of penetrating nuclear radiation developed in recent years in the Institute of Nuclear Research are reviewed. The review includes guard-ring surface-barrier

detectors, silicon and germanium lithium drifted detectors, and windowless silicon surface-barrier lithium drifted detectors. The trends of development of the methods of semiconductor spectrometry are pointed out. (auth)

17837 SPARK CHAMBERS FOR MEASUREMENTS OF ELASTIC BACKWARD SCATTERING OF POSITIVE PIONS BY PROTONS. Guskov, B. N.; Hladky, J.; Ljubimov, A. L.; Matjusin, A. T.; Savin, I. A.; Vovenko, A. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Czech. J. Phys., B17: 274-84(1967).

Multiplate spark chambers were employed in measurements of elastic π^+p backward scattering. The basic characteristics of the spark chambers and their time variation are described and the measured recording efficiencies for one particle against a high background of other particles are given. (auth)

17838 CARRIER MULTIPLICATION IN SEMICONDUCTOR DETECTORS. Ogawa, I. (Rikkyo Univ., Tokyo). Nucl. Instrum. Methods, 49: 325-33(1967).

On the basis of a slightly modified version of the Townsend–Miller theory of electron avalanches accompanied by β-mechanism, it is shown that the observed dependence of the multiplication factor M in an internally amplifying semiconductor detector upon the position x_0 of the formation of primary electron-hole pairs should be attributed primarily to the marked difference in ionization coefficient between electrons and holes in the material and not to the non-uniformity of the electric field within the depletion region. A formula for $M(x_0)$ is presented together with its simplified forms in particular cases. Expressions and estimations are also given of the intrinsic fluctuation of avalanche sizes. (auth)

17839 VOLUME DISTRIBUTION OF PHOTONS CREATED IN LIQUID SCINTILLATORS BY DIFFERENT RADIATIONS. Rosenstingl, E. (Faculte de Medecine et de Pharmacie, Toulouse); Commanay, L.; Godeau, A.; Blanc, D.; Teyssier, J. L. Nucl. Instrum. Methods, 49: 334-40(1967). (In French).

The volume distribution of the number of photons created in a liquid scintillator which is irradiated by gamma rays was investigated. It follows the gamma ray flux variations. Starting from that result it was possible to reconstruct the differential spectrum of the pulses delivered by such a detector. The Compton peak of the spectrum is given by the scintillations which happen close to the surface of the liquid. (auth)

17840 THE ANGULAR DEPENDENCE OF THE SENSITIVITY OF GM COUNTERS. Polly, P. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Nucl. Instrum. Methods, 49: 346-51(1967).

The dependence of the sensitivity of GM counters on the angle between the tube axis and the incident beam as well as the rotational symmetry of some GM tubes (Philips 18503, 18504, 18509, 18522, 18529, 18550) was measured at two γ-energies (x-rays and ^{60}Co). The results are presented in graphical form and discussed. (auth)

17841 LINEARITY OF A Ge(Li) DETECTOR IN THE RANGE 0.5 TO 10 MeV. Levy, A. J.; Ritter, R. C. (Univ. of Virginia, Charlottesville). Nucl. Instrum. Methods, 49: 359-60(1967).

The linearity of an annular germanium lithium-drifted gamma detector was measured to be <0.046% over a range of 0.5 to 10 MeV. (auth)

17842 A NEW METHOD FOR MEASURING THE $\beta-\gamma$ CIRCULAR POLARIZATION CORRELATION. Schopper, H.; Behrens, H.; Mueller, H.; Goerres, J.; Juengst, W.; Appel, H. (Technische Hochschule, Karlsruhe, Ger. Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 49: 277-90(1967).

The conventional method of measuring the $\beta-\gamma$ circular polarization correlation is modified by using the γ-scattering magnet as a β spectrometer as well, with the β counter placed in front of the γ counter. This arrangement can easily be doubled, permitting measurements for $\theta = 0°$ and $\theta = 180°$ simultaneously. Two possible setups are discussed. Since systematic errors can be eliminated and fourfold information is obtained in a given time, accurate measurements, also for short-lived nuclei, are possible. Calculations for the detection efficiency and various corrections are presented. The performance of the setup is described and calibration measurements are reported. (auth)

17843 NONLINEAR DELAY LINES AND THEIR APPLICATIONS IN NUCLEONIC INSTRUMENTATION. Owens, A. R.; White, G. (University Coll. of North Wales, Bangor). Nucl. Instrum. Methods, 49: 291-6(1967).

The simple theory of nonlinear delay lines is given and it is shown how these lines produce a reduction in pulse rise-times. This feature of nonlinear delay lines is then exploited in three applications in the field of nucleonic instrumentation. These are: particle time of flight measurements, cyclotron timing pulses, and continuously variable delay lines. (auth)

17844 DIGITIZED BUBBLE COUNTING MICROSCOPE. Simmons, J. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods, 49: 297-300(1967).

A digitized microscope, which can be used to determine the relative ionization of the tracks of high energy, charged particles in a bubble chamber, is described. The method of analysis is given and the results obtained from measurements on the tracks of pions and kaons, at momenta between 0.1 and 1.3 GeV/c, are presented. (auth)

17845 ACCELERATOR RADIATION MONITORING AND DOSIMETRY WITH INTEGRATING PULSE DISCHARGE IONIZATION CHAMBER DETECTORS. Distenfeld, C.; Bishop, W.; Lamplough, J. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 49: 309-15(1967).

Integrating pulse discharge ionization chambers were successfully used as detectors for portable dose integrators, environmental area monitors, and for high energy pulsed accelerator monitoring system. The ion chamber physically consists of a pressure vessel, internally mounted gas discharge tube, capacitors, anode support structure, and optional polyethylene inner lining. Chambers are available with argon, freon, or ethylene gas filling to about 10 atm. Gamma sensitivity depends on the filler gas, liner, and internal capacitance and may range from 2×10^{-4} to 5 R/pulse. The gamma and neutron energy response characteristics of freon and ethylene chambers together with rate dependence effects, were investigated and are discussed. Detailed consideration of chamber characteristics is justified by a general lack of this information from either the maker or other investigators. A transistorized portable, dose integrator, with adjustable alarm level, was developed as an aid in controlling mission exposure to either gamma or mixed field radiation. The device can be set to alarm at any absorbed dose between 0.25 and 600 mrad in increments of 0.25 or 0.6 mrad. Cosmotron area monitoring consists of a sixteen channel system designed to alarm above about 1.2 mrem/h. In each channel pulses are integrated on two registers, one resettable after appropriate data recording, and the other continuously running. (auth)

17846 COINCIDENCE LOSSES DUE TO PILE-UP IN CROSSOVER-TIMING SYSTEMS. Blatt, S. L. (Ohio State Univ., Columbus). Nucl. Instrum. Methods, 49: 235-9(1967).

In coincidence experiments where fast timing information is derived from the zero-crossing point of a double-differentiated pulse, counting losses can occur if the crossover point shifts beyond the resolving time of the fast coincidence circuit. Pulse pile-up can produce such a shift and losses can be significant. Correction for or elimination of these losses is necessary wherever precision in the absolute number of coincidence counts, or the relative number at different energies and angles, is desired. (auth)

17847 VERSATILE ELECTRON-GAMMA CORRELATION SPECTROMETER. Falk, F.; Toernkvist, S.; Snellman, H.; Thun, J. E. (Uppsala Univ.). Nucl. Instrum. Methods, 49: 240-4(1967).

The construction of an electron-gamma directional correlation spectrometer is described. The electron momentum analysis is made by a lens spectrometer of a new type, allowing a resolution of 0.7%. The constructional details and the performance of the correlation set-up are described with emphasis on the electronic arrangements for automatic operation and for current supply and spectra recordings. (auth)

17848 FABRICATION OF SURFACE-BARRIER NUCLEAR PARTICLE DETECTORS FROM p-TYPE SILICON. Mathew, P. J. (Univ. of Wellington, New Zealand); Chapman, N. G.; Coote, G. E. Nucl. Instrum. Methods, 49: 245-7(1967).

A simple method is described by which surface barrier detectors of excellent performance can be constructed from p-type silicon of resistivity up to at least 5000 ohm·cm. The rectifying front electrode is a vacuum evaporated aluminum film and the rear electrode is a similar film of gold. An important feature of the method is that the silicon surface is prepared by gradually quenching the CP4A etchant with concentrated nitric acid, followed by slow decanting with deionized water. Unencapsulated detectors show excellent long term stability in both air and vacuum. For detectors of area 20 mm^2 typical energy resolution (fwhm) for 5.5 MeV alpha particles is 30 keV. Thin totally depleted detectors were successfully made in this way and the surface preparation technique appears to have advantages in the fabrication of conventional surface barrier detectors from n-type silicon. (auth)

17849 SPLIT-POLE MAGNETIC SPECTROGRAPH FOR PRECISION NUCLEAR SPECTROSCOPY. Spencer, J. E.; Enge, H. A. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Instrum. Methods, 49: 181-93(1967). (MIT-2098-270).

A split-pole, broad-range magnetic spectrograph was designed that uses the fringing fields associated with four pole boundaries to obtain two-directional focusing over the full momentum range of $p_{max}/p_{min} \approx 2.8$ (energy range $E_{max}/E_{min} \approx 8$). The spectrograph is also approximately second-order focusing in the plane of dispersion (median plane) over this entire range. Different magnetic configurations (pole shapes) were simulated by computer and used in a program designed to trace rays of different initial conditions through the spectrograph. These computer experiments were then used to optimize the design and resulted in an instrument for which the median-plane aberration of second order was zero or very small over the entire energy range. Measured peak shapes and resolving power are in good agreement with calculations. A resolving power better than $p/\Delta p = 5000$ was demonstrated in the $^{106}Pd(d,p)^{107}Pd$ reaction with a 50 $\mu g/cm^2$ target and a solid angle of 0.8 msterad. (auth)

17850 ROTATING CRYSTAL TIME-OF-FLIGHT SPECTROMETER FOR SCATTERING LAW MEASUREMENTS WITH SLOW NEUTRONS. THEORETICAL ANALYSIS AND DESIGN CONSIDERATIONS. Carvalho, F.; Ehret, G.; Glaeser, W. (Kernforschungszentrum, Karlsruhe, Ger.). Nucl. Instrum. Methods, 49: 197-216(1967).

The application of a rotating mosaic crystal as slow neutron monochromator and chopper in connection with a time-of-flight spectrometer for inelastic neutron scattering measurements in condensed matter is discussed. Effects unique to this monochromating technique, e.g. the Doppler effect and neutron storage effects are described quantitatively. Several resolution functions describing the performance of this type of spectrometer are given. Using the derived relations finally a reference design of a possible high resolution double spectrometer is outlined. (auth)

17851 DEVELOPMENT OF NEON TUBE HODOSCOPE CHAMBER AS A DETECTOR OF IONIZING PARTICLES. Bandyopadhyay, B. K.; Bhattacharya, Subhra; Sengupta, R. L. (Presidency Coll., Calcutta). Indian J. Phys., 40: 419-21(July 1966).

The construction of a particle detector called the neon tube detector is discussed. The details about the processing of the tubes, gas filling and the construction of the chamber as well as the electronics so used is presented lucidly. The advantage and disadvantage of this type of detector and the possible cosmic ray experiments that can be performed with the help of this instrument are discussed. A photograph of a single particle, presumably a muon which passes through the chamber and thereby illuminating all the twenty tubes in a column and not the other adjacent tubes is presented. (auth)

17852 FLOOR MONITOR FOR ALPHA CONTAMINATION. Splichal, W. F. Jr. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Health Phys., 13: 411-12(Apr. 1967). (DP-MS-66-23).

An inexpensive floor monitor is described for surveying large areas for alpha contamination. The instrument will survey floors faster and more conveniently than portable survey instruments with small detectors. The instrument is also more accurate than smear techniques, which do not detect fixed contamination. It is based on a large air-filled porportional counter. (UK)

17853 TABLES FOR CALCULATING GEOMETRY FACTORS FOR DISK SOURCES AND DETECTORS. Lindeken, C. L.; Montan, D. N. (Univ. of California, Livermore). Health Phys., 13: 405-7(Apr. 1967). (UCRL-70013).

The efficiency of counting systems is usually determined from the counter response to a calibrated source. Whenever this procedure is used, however, questions invariably arise as to the integrity of the standard source, or indeed the validity of the primary calibration. As a check, therefore, it is often helpful to be able to calculate the disintegration rate from counting rate data. Among the factors necessary for this calculation is the detector-sample geometry. Tables of geometry factors for various disk-source and detector configuration assuming a uniform isotropic source and a totally absorbing detector are given. (UK)

17854 FRACTION OF SOLID ANGLE SUBTENDED BY THE DETECTOR TO THE SOURCE. Sastry, A. V. R.; Ramamurty, S. (Andhra Univ., Waltair, India). Proc. Indian Acad. Sci., Sect. A, 64: 224-8(Oct. 1966).

A general formula for the solid angle subtended by the detector to the radioactive source is derived. (auth)

17855 LIMITS TO RESOLVING POWER IN PHOTOELECTRON SPECTROSCOPY. Turner, D. W. (Imperial Coll. of Science and Tech., London). Nature, 213: 795-6(Feb. 25, 1967).

The energy spectra of electrons ejected in gaseous photoionization by undispersed radiation from rare gas discharges (molecular photoelectron spectroscopy) provide a rich source of new electronic and vibrational data on the states of the resultant ions. With regard to experimental detail, the energy discrimination of the retarding field analyzer was improved from ~0.5 to 0.05 eV. In view of this it is possible to discern vibrational fine structure corresponding to the formation of more or less vibrationally excited ions of diatomic molecules of various gases and of certain excited states of polyatomic molecular ions where only one vibrational mode is excited. When combinations of different vibrational modes occur, however, the resolution is insufficient to separate the various component lines. The present communication discusses the fundamental restrictions on the attainment of better resolution, and outlines some studies with various gaseous systems. (UK)

17856 DETECTION OF 160 MeV PROTONS BY A LITHIUM-DRIFTED GERMANIUM COUNTER IN A SIDE-ENTRY ORIENTATION. Gruhn, C. R. (Michigan State Univ., East Lansing); Kuo, T.; Gottschalk, B.; Kannenberg, S.; Wall, N. S. Phys. Lett., 24B: 266-7(Mar. 20, 1967).

A lithium-drifted germanium counter was constructed and used to measure the energy of 180-MeV protons with a resolution of 650 ± 50 keV (f.w.h.m.). (auth)

17857 NEW METHOD OF ELECTRONIC SCANNING OF TRACKS IN NUCLEAR EMULSIONS. Lepri, Franco; Manfredini, Augusta. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 1026-31(June 1966). (In Italian).

A new method for electronic scanning and detection of tracks in nuclear emulsion is described. The results discussed indicate the possibility of constructing an automatic apparatus which can follow tracks and perform measurements at a speed one or two orders of magnitude greater than the speeds up to now obtained. (auth)

17858 LEAST-SQUARE DETERMINATION OF CAMERA POSITIONS IN BUBBLE CHAMBERS. Posch, Margit; Sebestyen, Akos; Telbisz, Ferenc. KFKI (Kozp. Fiz. Kut. Int.)Kozlem., 14: 415-17(1966). (In Hungarian).

An iteration method for determining the positions of cameras in bubble chambers is described. The procedure was tested in a CERN-type 30-cm hydrogen chamber. (auth)

17859 TEMPERATURE DEPENDENCE OF THE SCINTILLATION DECAY TIME AND INTENSITY OF CsI(Tl) EXCITED BY 8.78 MeV α-PARTICLES BETWEEN 160 TO 300°K. Novak, Dezsoe. ATOMKI (At. Kut. Intez.) Kozlem., 8: 293-313(Dec. 1966). (In Hungarian).

It is well-known in the literature, that the scintillation in CsI(Tl) excited by ionizing particles, consists of two components, one with a longer and one with a shorter decay-time. A fairly large number of data was published on the parameters of the fast component. However, in connection with the slow component our knowledge is rather incomplete. It was known from several communications, that its decay-time is about 7.0 μsec at room-temperature. One reference found an exponential increase of the decay time towards low temperatures in case of proton excitation. In case of alpha excitation the decay time of the slow component was not studied separately. Besides, there were no data on the intensity and efficiency. Experimental investigations were performed on the alpha induced scintillation of CsI(Tl) within the temperature range of 160 and 300°K, mainly to examine the slow component. Alpha particles of 8.78 MeV energy served as the exciting radiation. A CsI(Tl) crystal containing 0.1 mol % Tl was used together with an RCA 6342-A multiplier. The electronic leakage time constant was 130 μsec. The decay of each component proved to be exponential in time. At room temperature, the decay times of the fast and slow components were 0.56 and 5.75 μsec respectively. Within 160 and 300°K both decay-times increased exponentially as a function of 1/T with an activation energy of 0.0769 ± 0.01 eV (fast component) and of 0.046 ± 0.011 eV (slow component). The initial intensity of the fast component decreased exponentially as a function of 1/T with an activation energy of 0.0766 ± 0.01 eV. The total light-outputs of both components were roughly equal. The light output of the fast component was temperature independent, while that of the slow component was increasing with temperature between 160 and 210°K and decreasing with an activation energy of 0.036 ± 0.016 eV between 210 and 300°K. The existence of a further third component below 210°K with a few hundred μsec decay-time seems likely on the basis of the present measurements. (auth)

17860 ORGANIC SCINTILLATORS WITH 2-ETHYL NAPHTHALENE AS A SOLVENT. Carter, J. G.; Christophorou, L. G. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 1883-90(Mar. 1, 1967). (ORNL-P-2593).

The emission spectra and the integrated emission intensities for 11 efficient scintillator solutes in 2-ethyl napthalene excited by x rays are reported. Data are also presented on the quenching of scintillation emissions by various materials used for loading liquid scintillators. Pulse heights under β- and γ-ray excitation are also given, and new, efficient liquid scintillators are suggested. The role of solvent excimers in organic scintillators is discussed. (auth)

17861 CHARACTERISTICS OF A PERLOW RECOIL-PROTON SPECTROMETER. Marseguerra, M.; Porceddu, C. M. Comit. Naz. Energ. Nucl., Notiz., 13: No. 1, 40-52(Jan. 1967). (In Italian).

After a brief description of C.N.E.N.'s Perlow type telescopic spectrometer and of the calibration work done with the Padua University's 5.5-MeV Van de Graaff accelerator, the problems connected with the pulse-formation mechanism, a knowledge of which is of basic importance towards the determination of the constants of the electronic detection instruments and towards the analysis of experimental data are discussed. (auth)

17862 EXPERIMENTAL PEAK/TOTAL RATIOS OF A 4" × 4" NaI(Tl) CRYSTAL. Christaller, G. (Karlsruhe Nuclear Research Center, Ger.). Nucl. Instrum. Methods, 50: 173-6(1967).

The peak/total ratios of a 4" × 4" NaI(Tl) crystal were determined at the distances 45 cm, 30 cm, 15 cm and 7.5 cm. Neither shielding nor a collimator was used. (auth)

17863 ENERGY DEPENDENCE OF PULSE HEIGHT DEFECT WITH FISSION FRAGMENTS IN A SILICON SURFACE BARRIER DETECTOR. Andritsopoulos, G. (Univ. of Reading, Eng.). Nucl. Instrum. Methods, 50: 177-8(1967).

An energy dependence of pulse height defect is observed above 100 MeV for fission fragments of the same mass. The method used involves the measurement of the correlated energies and velocities of the fission fragments from ^{235}U, by using a time-of-flight technique with Si-surface barrier detectors for the fragment detection. (auth)

17864 OPTIMUM DESIGN OF EXPERIMENTS ON EXPONENTIAL ABSORPTION WITH n OBSERVATIONS. Hemingway, J. W. (Atomic Power Constructions Ltd., Sutton, Eng.). Nucl. Instrum. Methods, 50: 61-70(1967).

An analysis is given of the statistical error in the measurement of the absorption coefficient when the experiment involves the counting of random events (as in nuclear physics). Optimum designs which minimize the statistical error are presented for a wide range of background counting rate (zero and 0.001 to 100 times the incident rate) and for various numbers of observations (2 to 30). Both constant absorber volume and constant intercepted beam area are considered. Some restrictions are introduced to facilitate the optimization calculations, but they are likely to be in line with many experimental arrangements and alternative restrictions are examined, so the limitation imposed is not unduly severe. The smallest error is found to obtain under the restriction to equal counting times for the different absorber thicknesses with equal increments in thickness; nevertheless equal weighting of the individual observations, again with equal thickness increments, is preferred if a linearity check of the usual semi-log plot is required. At large background, the error for a given total counting time decreases as the number of observation points is increased, and errors smaller than those of the ideal designs with n = 2 can be achieved in both the constant absorber volume and constant intercepted beam area cases. This is true even at small background in the case of equal counting times with equal thickness increments at constant absorber volume, but the effect is more pronounced at large background. All the optimum thicknesses and counting times quoted are readily achievable in practice and, since they are not very strongly dependent on background, an imprecise initial measurement of the background will suffice for planning the experiment. (auth)

17865 FIRST RESULTS ON PROTON DEUTERON DISCRIMINATION WITH A SINGLE SEMICONDUCTOR DETECTOR. Alberigi Quaranta, A.; Martini, M.; Ottaviani, G.; Zanarini, G. (INFN, Bologna). Nucl. Instrum. Methods, 50: 169(1967).

An experiment is described whereby the charge collection time in semiconductor detectors can be determined by measuring the amplitude of the output current pulse. (B.G.D.)

17866 OXYGEN-FREE, ALUMINUM DOPED GERMANIUM FOR LITHIUM DRIFTING. Edwards, W. D. (Defence Research Telecommunications Establishment, Ottawa); Wilburn, C. Nucl. Instrum. Methods, 48: 357-8(Mar. 1, 1967).

A description is given of a method of growing germanium crystals which are effectively oxygen-free and suitable for the fabrication of gamma ray spectrometers by the lithium drift process. Aluminum is used both as p-type dope and as a getter for oxygen. (auth)

17867 CONSTRUCTION AND USE OF A NEUTRON MONITOR FOR MULTIPLICITY STUDIES. Niemi, Sauli P. A. (Univ. of Oulu, Finland). Ann. Acad. Sci. Fenn., Ser. A VI, No. 214, 1-50 (1966).

The neutron monitor, 9-NM-64, was constructed in the Department of Physics, University of Oulu. The counting electronics were designed in such a way that measurements on the multiplicity etc., can be made without disturbing the ordinary continuous recording. An automatic device was also constructed for pressure correction capable of correcting the counting to within an accuracy of 0.1 mb. The recordings of the 9-NM-64 at Oulu were compared with the recordings of the 48-NM-64 at Deep River, Canada. The life time of the neutrons in the 9-NM-64 at Oulu was measured to be 346 μsec ± 3 μsec. An equation taking into account random coincidences, radioactive background of counter tubes, the finite duration of the registration cycle and other characteristics of the measuring device was derived for the mean recorded multiplicity $\overline{m}$. The time analyzer used in measurements was programmed to operate automatically. The mean recorded multiplicity $\overline{m}$ was observed to vary as a function of the atmospheric pressure with the pressure coefficient $d\overline{m}/dp = -0.00023 \pm 5 \cdot 10^{-5}$/mb. At a pressure of 1000 mb $\overline{m}$ turned out to be $\overline{m} = 1.405 \pm 9 \cdot 10^{-4}$. (auth)

17868 LARGE DETECTOR, ANTICOINCIDENCE SHIELDED MULTIDIMENSIONAL GAMMA-RAY SPECTROMETER. Wogman, N. A.; Robertson, D. E.; Perkins, R. W. (Battelle-Northwest, Richland, Wash.). Nucl. Instrum. Methods, 50: 1-10 (1967). (BNWL-SA-519(Suppl.)).

A multidimensional gamma-ray spectrometer was fabricated using two 11" in dia. × 6" thick NaI(Tl) crystals which are shielded from their phototubes with 4-inch thick pure NaI light pipes. Each NaI(Tl) crystal is surrounded by a 36" dia. × 18" thick plastic phosphor which functions as an anticoincidence shield. The spectrometer is coupled to a 4096 channel multiparameter analyzer and uses the gamma-ray decay characteristics of each radionuclide for its identification and measurement. This is accomplished by viewing the sample with two NaI(Tl) detectors operating in coincidence and cancelling those events not totally absorbed in the principal detectors by the plastic phosphor anticoincidence annulus. Coincidence counts are stored in the energy-energy plane of the memory according to their photon energies, while single gamma-rays which interact with either crystal are stored in a normal manner on the X or Y axis. The axis and energy-energy plane backgrounds, backscatter effects, Compton response and efficiency parameters are discussed along with some instrument applications. (auth)

17869 ALL-GLASS SPARK CHAMBER. Saro, S.; Povinec, P.; Srkalova, V. (Univ. of Komensky, Bratislava). Nucl. Instrum. Methods, 50: 11-12(1967).

A spark chamber with glass electrodes and with glass walls for experiments to run for a long time was made up. The dimensions of the chamber are 45 × 22 × 22 cm, the area of the glass electrodes is 323 cm^2. These electrodes with the vacuum evaporated metal layer can be used for more than 10^4 impulses without any significant changes of the performance of the chamber. The spark chamber was filled to atmospheric pressure with technical argon. If the electrodes are parallel with an accuracy of a few μm, if they are sufficiently planar and have a smooth surface it is possible to reach a good voltage characteristic with this gas filling too. The plateau obtained in this device was longer than 3 kV with negligible slope. (auth)

17870 INFLUENCE OF PHOTOELECTRON STATISTICS ON TIME-CORRELATIONS IN FAST COINCIDENCE MEASUREMENTS. Halling, H.; Mayerhofer, S.; Nabielek, H.; Ujlaki, E. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Nucl. Instrum. Methods, 50: 22-8(1967).

Prompt curves with an exponential slope are observed in lifetime measurements of low energy γ transitions by means of a NaI(Tl)-scintillator. In this case the statistics of electrons emitted from the photocathode determines the resulting time-correlations. These time-correlation functions are calculated on the basis of a simple statistical model. The agreement between the experimental curves and the calculations is demonstrated and an instruction for optimum timing is given. (auth)

17871 SPECTROMETER FOR NEUTRON CAPTURE GAMMA RAY STUDIES. Broman, L. (Chalmers Univ. of Tech., Goteborg). Nucl. Instrum. Methods, 50: 29-37(1967).

Due to the large Compton background from intense gamma lines the usefulness of the Ge(Li)-detector for the investigation of neutron capture gamma ray spectra between 500 and 2000 keV is restricted to the determination of strong gamma lines. By placing the Ge(Li)-detector in the reflected beam from a single crystal spectrometer this background can be completely suppressed within a variable energy interval. This combination was tested on the

complex gamma yield from thermal neutron capture in ^{167}Er. When using the Ge(Li)-detector as a photo effect spectrometer gamma rays up to about 1500 keV were detected. The energy resolution of the combined spectrometer, using this particular Ge(Li)-detector is better than that of double flat and curved crystal spectrometers above about 700 keV. Recent developments in solid state detector techniques will appreciably lower this limit. (auth)

17872 AVERAGE PULSE SHAPE OBSERVATION BY SAMPLING METHOD AND ITS APPLICATION TO PULSE SHAPE DISCRIMINATION. Tojo, A. (Tokyo Univ.). Nucl. Instrum. Methods, 50: 38-44(1967).

A method for obtaining an average shape from statistically varying pulses is described. Basic circuitry designed for this purpose including a fast amplifier, sampling circuits, sampling pulse generators, analog memories, an analog divider etc., has shown satisfactory performances. Also proposed is a new method for pulse shape discrimination utilizing the same technique, and several methods of extracting parameters for discrimination from sampled values are presented. The proposed method for shape discrimination turned out to be feasible from the observed results obtained with the presented system. (auth)

17873 INFLUENCE OF THE ENTRANCE WINDOW ON THE ENERGY RESOLUTION OF SURFACE BARRIER SEMICONDUCTOR DETECTORS. Fabri, G.; Karolyi, J.; Svelto, V. (Laboratori CISE, Milan). Nucl. Instrum. Methods, 50: 50-2(1967).

The energy straggling due to the gold layer of the semiconductor surface barrier detector was calculated and measured. This effect on the linewidth is appreciable in the case of α particles and heavier ions and sets a limit to the resolution. The contribution to the linewidth due to the gold layer is for the usual thicknesses about 10-14 keV in fwhm for 6-MeV α particles. (auth)

17874 SPHERICAL ABERRATION EFFECTS ON THE TRANSMISSION, LUMINOSITY, AND RESOLUTION FOR A β SPECTROMETER WITH TROCHOIDAL TRAJECTORIES. Mugnier, D.; Beuzit, P.; Lafoucriere, J. (Faculte des Sciences, Lyon). Nucl. Instrum. Methods, 50: 77-86(1967). (In French).

A β spectrometer with trochoidal trajectories has an excellent luminosity together with a fairly good resolution, particularly when choosing a tangential mean direction of emission. Though it is necessary to use sources of small area, the luminosity of the apparatus for the same resolution is better than for double focusing spectrometers. (auth)

17875 NEW X-RAY SPECTROMETRIC TECHNIQUE. Koehler, D. R.; Grissom, J. T. (Army Missile Command, Redstone Arsenal, Ala.). Nucl. Instrum. Methods, 50: 87-90 (1967).

Solutions to the integral equation of the first kind allow one to exploit many experimental measurements in a more informative fashion. The solution of the integral equation associated with the voltage pulse generated in a solid ionization chamber which offers one a new spectroscopic technique for x-rays is presented. The method of solution and the results obtained with diamond as a chamber material are presented. (auth)

17876 SENSITIVITY OF COSMIC GAMMA-RAY TELESCOPES. Dennis, B. R.; Share, G. H. (Univ. of Rochester, N. Y.). Nucl. Instrum. Methods, 50: 100-4(1967).

A simple Monte Carlo program which enables a detailed analysis of the sensitivities of high-energy (≥50 MeV) gamma-ray telescopes is described. Results obtained using this method on operational telescopes are in good agreement with measurements made using a tagged photon beam. Advantages of this technique are assessed. (auth)

17877 METHOD FOR DETECTING MUONS STOPPING IN THE GAS OF AN ISOTROPIC DISCHARGE CHAMBER. Komarov, V. I.; Savchenko, O. V.; Fedyaev, N. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 50: 105-8 (1967).

A method was described for separating the pure beam of slow muons having small range dispersion in order to detect stopping muons in the gas of an isotropic discharge chamber. Muon beams of energies from 15 to 4.3 MeV were produced. The halfwidth of the range distribution for 4.3-MeV muons is 75 mg/cm^2 Al. The method was tested with the isotropic discharge chamber of the fiducial volume 80 × 80 × 30 cm^3. (auth)

17878 FAST NEUTRON TIME-OF-FLIGHT SPECTROMETER. Oliver, C. J.; Collinge, B.; Kaye, G. (Univ. of Liverpool). Nucl. Instrum. Methods, 50: 109-20(1967).

A neutron time-of-flight spectrometer was designed and constructed. It consists of a time-to-amplitude converter, a beam pulser and associated neutron detectors. The time-to-amplitude converter gives a time resolution of 3.5 × 10^{-10} sec using 56 AVP photomultipliers and small plastic scintillators. With two 10 × 5 cm NE213 liquid scintillators and 58 AVP photomultipliers the time resolution was 1.1 × 10^{-9} sec. From 10 to 100% of its range, the differential nonlinearity was ±0.3% and the integral linearity ±0.8%. The beam pulser produced beam pulses 2 nsec wide with a beam utilization of 10–12% and 1 nsec wide with a 6% utilization. (auth)

17879 CONSTRUCTION AND OPERATION OF THIN PARALLEL PLATE PROPORTIONAL COUNTERS. Hilberg, R. H.; Draper, J. E.; Alston, W. J. (Yale Univ., New Haven). Nucl. Instrum. Methods, 50: 121-4(1967).

A proportional counter of parallel plate geometry with uniform gain, to within 10%, and 100% efficiency over a large area was developed for the detection of densely ionizing particles. The unit used has a gas gain of 500 for electron collection and several thousand for ion collection. The electron pulse rise time is 30 ns for an argon–methane mixture (P-10) or methane counter gas at 150 mm Hg pressure with time jitter for the zero crossing of a double delay-line-shaped pulse of less than 3 ns. The ion pulse rise time is about 5 μsec. The area is 50 cm^2 and the effective thickness about 4 mg/cm^2, for a detector consisting of 3 nickel foils, each 1 μm thick and two 0.163″ gaps containing the counter gas. These detectors were used successfully in measuring proton polarizations. For proton energies above 10 MeV or below 20 keV, the signal-to-noise ratio starts to limit their usefulness in fast-resolving time networks, but for more densely ionizing radiation they give good signal-to-noise ratios: e.g., about 100 to 1 for 5-MeV α particles, using ~60 ns clipping time. For longer clipping times, the signal-to-noise ratio increases rapidly. (auth)

17880 MULTIPLE COUNTER FOR A BETA SPECTROMETER. Bartlett, A. A.; Spenny, D. L. (Univ. of Colorado, Boulder). Nucl. Instrum. Methods, 50: 125-31(1967). (UCOL-535-558).

A single structure consisting of fourteen parallel proportional counters in a plane array was constructed and installed in the University of Colorado beta-ray spectrometer. All counters are independent of one another and each counter records electrons of a different momentum value. Twelve counters record spectral data over a range of intensities, while two record background. All twelve data counters demonstrated resolutions of the order of 0.1% at a spectrometer transmission of 0.4% of 4π. (auth)

17881 TRANSISTORIZED LINEAR GATE. Mills, A. P. (Brandeis Univ., Waltham, Mass.). Nucl. Instrum. Methods, 50: 132-6(1967).

A linear gate for scintillation spectroscopy is described. ¼% linearity, high temperature stability and small (0.03%) pedestal and feedthrough are achieved by negative feedback and subtraction of both signal and gate pulse error signals. Circuit details are given. (auth)

17882 METHODS FOR MEASURING FLUX DENSITY AND DOSE RATE EQUIVALENTS OF NEUTRONS IN THE ENERGY REGION BETWEEN THERMAL ENERGIES AND 50 MeV. Nachtigall, D. (EURATOM, Geel, Belg.); Rohloff, F. Nucl. Instrum. Methods, 50: 137-40(1967). (In German).

The neutron scintillation counter of the Bonner type with LiI(Eu) crystal and polyethylene spheres is frequently used in the field of radiation protection. Several methods were developed for measuring dose rate equivalents, absorbed dose rates and flux densities in the energy range up to 10 MeV. By means of new calculations by Hansen and Sandmeier we enlarged the measuring range up to 50 MeV. Measurements with the bare counter and with 4 spheres (2″, 5″, 11″ and 18″ dia.) give count-rates from which the flux density φ and the dose rate equivalent D_e can be obtained. (auth)

17883 SIMPLE AUTOMATIC ANGULAR CORRELATION SYSTEM. Meulenberg, A. Jr.; Ramayya, A. V.; Van Nooijen, B.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Nucl. Instrum. Methods, 50: 157-64(1967).

The automation of a conventional gamma-gamma or beta-gamma directional correlation system with one fixed and one movable detector is described. The system described is very simple, reliable and easily adaptable to any type of angular correlation work. The cost of the system is between $500 and $3,000, depending upon the parts available, for example from a tube-type multichannel analyzer. (auth)

17884 COLD FINGER CRYOSTATS FOR LITHIUM-DRIFTED GERMANIUM DETECTORS. Buhler, S.; Marcus, L. (Institut de Physique Nucleaire, Orsay, France). Nucl. Instrum. Methods, 50: 170-2(1967).

Cold finger type cryostats of different shapes with self-containing vacuum are described. Very long cold fingers need internal liquid nitrogen circulation in order to shorten the cool-down period and to get lower temperatures of the detector. Conditioning and performances of such cryostats are described. (auth)

17885 EXTERNAL STANDARDIZATION IN HOMOGENEOUS LIQUID SCINTILLATION COUNTING OF ^{3}H, ^{14}C, AND ^{32}P, SINGLY OR IN COMBINATION. De Wachter, R.; Fiers, W. (Univ., Ghent). Arch. Int. Physiol. Biochim., 74: 915-17(1966).

A major difficulty in liquid scintillation counting of β-emitting isotopes was caused by the shift in optimal counting conditions and in counting efficiency brought about by quenching substances present in the sample. A calibration procedure to correct for quenching effects is described for use with a Packard Tri-Carb Model 3324 instrument, provided with an external ^{226}Ra γ source and three channels with independent amplification. The activity of the isotopes was determined by the differential counting method, i.e., using a low and an upper level discriminator. For counting the external standard, no upper discriminator was used. Integral discriminator bias curves relating efficiency to gain were constructed for each isotope using standards quenched to different extents. When efficiency was plotted vs external standard count rate on a double logarithmic graph, straight lines were obtained, the slope of which was steeper the lower the particle energy of the isotope. In double label experiments, efficiency for the higher energy isotope in the channel optimized for counting the lower energy isotope was found to increase linearly with quencher concentration. This efficiency was therefore a linear function of the logarithm of the external standard count rate. Beside these efficiency calibration curves, gain calibration curves should be constructed that relate the increase in balance point gain to the observed external standard count rate. The major advantage of external standardization over other quenching corrections was in the easy determination of the quenching level of a sample prior to the counting operation. This allowed determination of instrument settings and resulted in minimum efficiency losses for singly labeled samples in addition to maximum resolution for doubly or triply labeled samples. (BBB)

17886 SEMICONDUCTOR JUNCTION DETECTOR APPLIED TO SOME ALPHA PARTICLE REACTIONS. Davids, Cary Nathan. Edmonton, Alta., Univ. of Alberta, 1962. 62p.

Thesis.

A fast-neutron monitor is described which uses the pulse-shape discriminating properties of a liquid scintillator to make it insensitive to gamma radiation. The efficiency of the monitor as a function of neutron energy is given, followed by a discussion of the factors which influence the pulse-shape discrimination process. The use of the semiconductor junction detector as a charged-particle spectrometer is discussed, and the experimental arrangement and target chamber are described. Basic characteristics of the detector are derived from the solution of Poisson's equation, and the effects of excessive charged-particle bombardment on the resolution of a detector are shown to be small. A description of angular-distribution measurements made on the reactions $^{19}F(p,\alpha_0)$ ^{16}O and $^{19}F(p,\alpha_1)^{16}O$ is followed by a preliminary analysis of the charged-particle spectrum resulting from the bombardment of ^{11}B by 0.5 MeV deuterons. Finally, recommendations for improving the apparatus are proposed. (auth)

17887 CALCULATED GAMMA RAY RESPONSE CHARACTERISTICS OF SEMICONDUCTOR DETECTORS. Wainio, Kendle Murray. Ann Arbor, Mich., Univ. of Michigan, 1965. 267p.

Thesis.

A Monte Carlo program was written to calculate gamma ray response parameters of germanium and silicon semiconductor detectors. The response parameters considered are: the total absorption probability, the intrinsic efficiency, the double escape peak efficiency, the pulse height distribution, and numerous parameters of analytic interest such as the probability for secondary electron leakage. Results were obtained for germanium and silicon detectors for several thicknesses ranging from 1 mm to 12 mm. Where direct comparisons can be made, the predictions of the program are in good agreement with experimental data. Calculations are limited to photon energies less than 2.5 MeV for the total absorption probability and less than 6 MeV for the double escape peak. These limits are set by the approximate method used to account for secondary electron leakage. Secondary electron leakage is calculated by using escape probability data generated with an electron penetration program also based on the Monte Carlo method. Predictions of this program are shown to be in good agreement with experimental data for the probability of electron transmission through slabs and for energy deposition in infinite media. Previously unavailable data for energy deposition in slabs and for the probability of electron escape from semi infinite media of germanium and silicon are reported. It is shown that the data for the average energy of transmitted electrons can be well represented by a single universal curve which holds for all energies less than 2 MeV, in analogy with the procedure commonly used to correlate transmission probabilities. (Dissertation Abstr.)

17888 CERTAIN OPERATING CHARACTERISTICS AND HEALTH PHYSICS APPLICATIONS OF LARGE VOLUME LIQUID SCINTILLATION COUNTERS. Ziemer, Paul Louis. Lafayette, Ind., Purdue Univ., 1963. 155p.

Thesis.

Operating characteristics of two large volume liquid scintillation counters were studied, and an investigation of the applicability of these counters to routine Health Physics environmental monitoring was made. The first counter was a 2π unit with a detector tank, containing 90 gallons of scintillator solution, mounted in a horizontal position and shielded by 6 inches of steel. The semicircular sample well was 72 inches long and 20 inches in diameter. Six 16-inch photomultiplier tubes provided good light collection efficiency. Differential spectra for ^{137}Cs, ^{54}Mn, ^{65}Zn, ^{60}Co, and ^{40}K were determined and the energy calibration was established. Half-resolution values of 42.8%, 37.7%, 33.1%, 34.1% and 37.8% respectively were obtained for the radionuclides examined. The precision and stability of the counting system were studied and found to be excellent. The second large volume liquid scintillation counter studied was a 4π system consisting of an annular tank containing 23 liters of scintillator solution surrounding a 4-inch diameter well. This counter, utilized four 5-inch photomultiplier tubes and was completely shielded by five inches of rolled iron. Differential spectra of ^{137}Cs, ^{54}Mn, ^{65}Zn, ^{60}Co, and ^{40}K were obtained and half-resolution values of 42.4%, 37.4% 32.8%, 31.0%, and 29.4% respectively were found. The lower limits of sensitivity for measuring low concentration samples were established for three radionuclides of interest. It was found that a 0.85 $\mu\mu$C/ml solution of ^{60}Co could be measured to $\pm 5\%$ for a counting time of 5 minutes. Likewise, corresponding sensitivities for ^{65}Zn and ^{137}Cs were 1.45 $\mu\mu$C/ml and 0.86 $\mu\mu$C/ml, respectively. The utilization of these liquid scintillation counters to routine Health Physics environmental monitoring was investigated. The usefulness of liquid scintillation techniques for gross gamma measurements of air, precipitation, and soil samples, as well as for purposes of personnel monitoring was demonstrated. (Dissertation Abstr.)

17889 METHOD AND APPARATUS FOR THE PRODUCTION OF SEMICONDUCTOR LITHIUM-ION DRIFT DIODES. (to Atomic Energy of Canada Ltd.). British Patent 1,062,997. Mar. 22, 1967. Priority date Apr. 30, 1964, Canada.

A method of producing lithium-drifted germanium diodes which comprises of applying a thin layer of lithium to one face of a slab of p-type germanium crystal and causing lithium from this layer to form on n-type region in the crystal, thereby creating a p-n junction, heating the crystal in a boiling liquid having a boiling point in the range of 50 to 70°C (chloroform), and applying a dc voltage across the p-n junction such that lithium ions will drift from the n-type region into the p-type germanium to form a wide intrinsic layer. (B.G.D.)

17890 LARGE VOLUME LITHIUM-DRIFTED DIODES. (to Atomic Energy of Canada Ltd.). British Patent 1,062,998. Mar. 22, 1967. Priority date Dec. 16, 1964, Canada.

A method of producing large volume lithium-drifted diode detectors with available crystals and with reasonable drift times is described. The method diffuses lithium into at least two surfaces of a crystal of p-type material, applying a bias voltage between the surfaces and an electric contact placed centrally on an end surface not diffused with lithium, and heating in a controlled atmosphere so that drifting takes place inwardly from the surfaces leaving a coaxial core of p-material of small size in the central region. (B.G.D.)

17891 IMPROVEMENTS RELATING TO SOLID STATE DEVICES. Freck, David Vernon; Rouse, Robert Lindsay; Wakefield, James (to Associated Electrical Industries Ltd.). British Patent 1,058,753. Feb. 15, 1967. Filed Nov. 2, 1962.

A method of manufacturing solid state p-i-n junction devices comprising a first stage in which lithium is diffused into a p-type semiconductor material so as partially to compensate the acceptors without changing the conductivity type of the semiconductor material, a second stage in which further lithium vapor is diffused part of the way through the semiconductor so as to change the conductivity type of the semiconductor material and form a p-n junction and a third stage in which a reverse bias is applied across the junction while heated to form an intrinsic region between the opposite conductivity type zones. The semiconductor material being is silicon or germanium. (B.G.D.)

17892 IMPROVEMENTS RELATING TO SOLID STATE RADIATION DETECTORS. Wakefield, James; Waters, Derek George; Pope, Rex Anthony (to Associated Electrical Industries Ltd.). British Patent 1,058,754. Feb. 15, 1967. Filed May 2, 1963.

Improvements to silicon and germanium radiation detectors

are described, which reduce the Compton effect arising in the detection of x and gamma radiation. (B.G.D.)

17893 FAST-NEUTRON DETECTOR. (to Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete). British Patent 1,058,775. Feb. 15, 1967. Priority date Nov. 20, 1962, Hungary.

A fast neutron detector is described which has a plurality of annular light-guides embedded in a mixture of a substance having a high hydrogen content and a scintillating substance, such as polyethylene and silver-activated zinc sulfide, respectively. (B.G.D.)

Radiation Dosimeters

Refer also to abstract 18268.

17894 (NP-16664) USE OF MICA AS A CONVENIENT AND SIMPLE DOSIMETER FOR BOTH SLOW AND FAST NEUTRONS. Price, P. B.; Walker, R. M. (General Electric Co., Schenectady, N. Y. Research Lab.). Feb. 1963. 16p. (GE-63-RL-(3253M)).

A new neutron dosimeter is described which consists simply of a slab of mica placed next to a layer of fissile material. Neutron-induced fission fragments leave tracks in the mica which can be etched out to form holes. The dose is determined either directly, by counting holes in an optical microscope, or indirectly, by measuring the flow rate of gas or solute ions through the holes. The characteristics, sensitivity, and potential uses of the dosimeter are discussed along with ways to read the dose of either thermal or fast neutrons. (auth)

17895 (UCRL-16507) MINIATURE SILICON DIODE AS A RADIATION DOSEMETER. Raju, M. R. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 9, 1965. Contract W-7405-eng-48. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The use of commercially available miniature silicon diodes as dosemeters, with particular reference to their application to biomedical facilities at cyclotrons, is discussed. They are simple and convenient, and their small size makes them ideal to use as beam profile detectors or to measure depth-dose distribution of small collimated beams. (auth)

17896 PRECISION DOSIMETRY SYSTEM SUITED FOR LOW TEMPERATURE RADIATION DAMAGE EXPERIMENTS. Andersen, H. H.; Hanke, C. C.; Soerensen, H. (Atomic Energy Commission, Risoe, Denmark). Rev. Sci. Instrum., 38: 511-13 (Apr. 1967).

A calorimetric system for dosimetry on a beam of charged particles is described. The calorimeter works at liquid helium temperature. The total dose may be measured with an accuracy of 0.3%, and the dose per area with 0.4%. No theoretical corrections are needed. (auth)

17897 DATA TRANSFER SYSTEM FOR THE DIGITAL ANALYSIS OF THERMOLUMINESCENT SPECTRA. Cook, K. J.; Mantel, J. (Wayne State Univ., Detroit). Health Phys., 13: 412-14 (Apr. 1967).

In the practical application of thermoluminescence in radiation dosimetry the problem of reproducible data is vital. A measure of absorbed dose is obtained by summing the light over part or the whole of the glow curve or by measuring the height of one of its peaks. Using existing measuring methods a variation in these peaks will cause a variation in readings for the same absorbed dose. A system for digitalizing the thermoluminescent glow curve and statistically analyzing it is described. (UK)

17898 RADON FILM BADGE. Geiger, E. L. (Eberline Instrument Corp., Santa Fe, N. Mex.). Health Phys., 13: 407-11 (Apr. 1967).

A special film badge was developed that is sensitive to radon gas. A sheet of alpha sensitive film is positioned inside the badge and is separated from a central recess by a light-tight window sufficiently thin to permit substantially unimpeded passage of α-particles. The radon gas diffuses into the central recess through small bores, where it decays by α-emission. The number of α-particles is determined by counting the alpha tracks in the film emulsion. The number of tracks is directly proportional to radon gas exposure. (auth)

17899 COUNTER FOR FAST NEUTRON DOSIMETRY. Murthy, K. B. S.; Muthukrishnan, G.; Sunta, C. M. (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 5: 26-9(Jan. 1967).

The design, constructional and operational details of a proton recoil proportional counter for use in fast neutron dosimetry is described. By proper selection of the proton radiators, the response of the counter is adjusted to suit the current recommendations of the International Commission on Radiological Protection regarding maximum permissible flux (MPF) of fast neutrons. The counter has a sensitivity of 34 counts/min/MPF for fast neutrons in the energy range of 0.2 to 14 MeV and gives directly the dose equivalent. The counter is highly stable and is about 150 times less sensitive to thermal neutrons as compared to fast neutrons and is insensitive to gamma rays. (auth)

17900 PROTOTYPE READER FOR LUMINODOSIMETERS. Baciotti, J. P. (Faculte des Sciences, Toulouse); Blanc, D.; Teyssier, J. L.; Francois, H.; Soudain, G. Nucl. Instrum. Methods, 50: 93-9(1967). (In French).

After having defined the quality criteria of a fluorimeter, the prototype that was constructed is described; it is made to be used with french silver (activated phosphate glass). Apparent predoses are lower than 400 mR; the linearity of the apparatus is ensured between 79 mR and 1,000 R; the degree of reproducibility is about 6%; the holder allows to read a series of 24 dosimeters. (auth)

17901 RADIATION DOSIMETRY. SECOND EDITION. VOLUME II. INSTRUMENTATION. Attix, Frank H.; Roesch, William C. (eds.). New York, Academic Press, 1966. 475p. $20.00.

The instrumentation used in radiation dosimetry is discussed. Topics include ionization chambers, Geiger-Mueller and proportional counters, scintillation detectors, chemical dosimetry, solid-state integrating dosimeters, solid-state electric conductivity dosimeters, dosimetry with photographic emulsions, and calorimetry. (B.G.D.)

17902 IMPROVEMENTS IN OR RELATING TO DOSIMETERS FOR X-RAYS AND GAMMA RAYS. (to Manufacture Belge de Lampes et de Materiel Electronique, SA: M.B.L.E.). British Patent 1,058,741. Feb. 15, 1967. Priority date Nov. 29, 1962, Belgium.

A thermoluminescent dosimeter for measuring radiation doses of gamma and x radiation is described. (B.G.D.)

17903 PHOSPHORS. (to The Harshaw Chemical Co.). British Patent 1,059,518. Feb. 22, 1967. Priority date Nov. 7, 1963, United States.

Thermoluminescent materials comprising of crystals of lithium fluoride characterized by being activated by at least one member of a first group of magnesium, calcium, and barium and at least one member of a second group consisting of aluminum, titanium, and europium are described. (B.G.D.)

Radiometric Instruments

Refer also to abstract 17801.

17904 DEVELOPMENT OF RI-METHANOMETER. 2. Matsuguma, Kiso; Oba, Shigeyoshi (Resources Research Inst., Kawaguchi, Japan). Saiko To Hoan, 12: 462-8(Sept. 1966). (In Japanese).

Based on the results of basic experiments two RI-methanometers were designed and manufactured. One of these is for O-100 percent methane and the other for O-10 percent methane, both having almost the same structures and electric circuits. This methanometer, contained in an explosion proof case, consists mainly of two ionization chambers, dc amplifier, power supply and alarm circuit. Its output, which is indicated on a 100 micro-ammeter scaled in methane percent, can also be connected to a self-balancing type electronic recorder. As alpha emitting source attached in each ionization chamber, 100 micro-curies of Ra(D + E + F) is used. Results of performance tests made in laboratory are summarized as follows: under constant atmospheric condition, both RI-methanometers proved sufficient accuracy to given methane concentration, pressure compensating chamber proved its validity to eliminate the effects of changes in atmospheric pressure, rapid changes in air temperature gave a zero-point shift to RI-methanometer, especially one for lower concentration (some modifications will be made further to improve this defect), and this methanometer also is not an exceptional one against the effects of other gases in sampled air, as was predicted from the basic experiments. (auth)

17905 CONSIDERATION ON THE USE OF RADIOELEMENTS IN THE MEASUREMENT OF GAS FLOW. Courtois, G.; Toudoire, B. (CEA, Saclay, France). Bull. Inform. Appl. Ind. Radioelem., No. 63, 6-12(Jan.-Feb. 1967). (In French).

The possibilities of using two radioactive methods for the measurement of gas flow are discussed. The discontinuous methods using radioactive tracers are examined. These include dilution methods, time integration, and two peak methods. The continuous methods using the ionization of the radiation of sealed sources are

also examined. The advantages and disadvantages of each type of method are given. (tr-auth)

17906 DETERMINING THE MOISTURE OF SUBSTANCES BY NEUTRON RADIATION. Dresia, Heinrich; Fischotter, Peter; Bessing, Reinhold (Rheinische Kalksteinwerke GmbH). British Patent 1,063,477. Mar. 30, 1967. Filed Sept. 13, 1963.

An apparatus for determining the moisture content of solid substances by neutron radiation consisting of a fast neutron source with a relatively short lifetime, and a thermal neutron-counting device such as a BF_3 counter is described. The BF_3 counter is partially encased in Cd which is progressively removed as the source decays. Hydrocarbon material such as synthetic plastic or resinous material is employed as a solid reflecting material. (F.S.)

Miscellaneous Instruments and Components

Refer also to abstracts 18502, 18756, and 18758.

17907 (AD-642416) SHELTER ATMOSPHERE MONITORING INSTRUMENTS. Final Report. Kapil, A. L.; Baschiere, R. J. (General American Transportation Corp., Niles, Ill. General American Research Div.). Jan. 1966. 73p. (GARD-1277). CFSTI $3.00 cy, $0.65 mn.

The potential sources of hazards in fallout shelters were identified and commercial instruments for monitoring them were surveyed. Three effective temperature meters and an air composition sensor for monitoring carbon dioxide were developed. Procedures for further shelter instrument development are recommended. (auth)

17908 (COO-1624-1) AUTOMATIC DATA ACQUISITION SYSTEM FOR SEMICONDUCTOR DEVICE TESTING. Bartling, Donald L. (Missouri Univ., Rolla). Feb. 1967. Contract AT(11-1)-1624. 104p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. Thesis.

An Automatic Data Acquisition System for determining the voltage current characteristics of semiconductor devices is presented. The system is capable of measuring currents in the range from 10^{-10} amperes to 200 milliamperes. The system includes various pieces of commercially available equipment plus several pieces of specially designed and fabricated equipment. The system yields a maximum of 59 data points each for both the base and collector characteristics of the transistor tested. The system is designed to perform a particular sequence of events. These events are controlled by a specially designed and fabricated piece of equipment called the control center. The sampling resistance alternately is switched into the base lead and collector lead of the transistor being tested and may have any of nine possible discrete values. An autoranging procedure selects one of the nine possible values using the voltage drop across the sampling resistance as a criterion. Base-emitter bias voltage and collector supply voltage are provided by commercial power supplies. The data are recorded by commercially available equipment and then provided to a computer for the data reduction process which yields the required v/I characteristics. This system is the fifth generation of a system originally developed at Sandia Laboratory. In the present system a cost saving of $9,000 was realized by the use of equipment specially designed and fabricated by the author. In addition, the present system is lighter in weight, more compact, and more versatile than the previous versions. (auth)

17909 (IPP-3/43) UEBERLEGUNGEN ZUM BAU EINES MEMBRANSTOSSWELLENROHRES FUER PLASMAEXPERIMENTE UND ERSTE MESSUNGEN. (A Diaphragm Shock Tube for Plasma Experiments). Nett, H. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1966. 101p. (In German). Dep. mn.

The planning, construction and testing of a diaphragm shock tube for plasma experiments are described. The flow processes occurring in such a tube (shock waves, contact discontinuities, rarefaction waves and also the reflection of shock and rarefaction waves) are first discussed separately and then treated together as the total flow. In this way a relationship is obtained between the initial conditions (the ratio of the initial pressures in the high-pressure and low-pressure sections and the type of gases used) and the velocity (Mach number) of the resulting shock wave. These estimates were made on the assumption that all the rare gases used as test gases and the hydrogen used as driving gas have constant specific heats. The calculations of the plasma parameters behind the shock front as a function of the Mach number show in what range a sufficiently conductive rare gas plasma can be obtained. Further calculations then establish criteria for the needed mechanical strength and evacuability of the diaphragm shock tube. Investigation of the influence of the boundary conditions, i.e., the finite lengths of the high-pressure and low-pressure sections, affords relations which give the necessary distance between the measuring point and the diaphragm and also determine adequate lengths for the high-pressure and low-pressure sections. These conditions guarantee a stipulated minimum measuring time and ensure that the plasma cylinder is sufficiently long. By calculating numerically the state variables in a shock heated argon plasma it was also possible to consider the ionization of the plasma. After a brief description of the diaphragm tube built on the above principle, an account is given of the measurements made with photomultipliers, a drum camera, and probes which respond to the temperature change in the shock front. These measurements give the shock front velocity and the measuring time as a function of the initial pressure ratio in the high-pressure and low-pressure sections and of the distance between the measuring point and the diaphragm. In the measuring range involved they also give the length of the plasma cylinder and the velocity of the contact front. The experimental results are compared with the calculated values. This shows that relaxation effects have a marked influence. (auth)

17910 (LA-DC-8367) COMPUTER DESIGN OF UHF POWER AMPLIFIER TUBES. Liska, Donald J. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 16p. (CONF-670307-19). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Improved computational methods were developed which can reduce the trial and error process in the development of certain microwave power tubes that employ cavities with cylindrical symmetry. It was found, for example, that the application of these computer codes to klystron cavities and internal cavity triodes reveals ways in which their performance can be improved and results in better understanding of experimental results. The computed results agree quite closely with measurements made of such quantities as frequency and operating efficiency. (auth)

17911 (NYO-3339-1) MICROWAVE SPECTROSCOPY AND ITS APPLICATION TO THE USE OF NEUTRAL ISOTOPES IN PLACE OF RADIOACTIVE TRACERS. Brinkerhoff, Joris M. (LFE, Inc., Waltham, Mass. Tracerlab Technical Products Div.). Oct. 7, 1966. Contract AT(30-1)-3339. 136p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Various techniques of microwave spectroscopy were studied with reference to the use of neutral isotopes as tracer materials. A breadboard microwave spectrometer was constructed as a starting point. This was then modified to provide greater sensitivity through the use of long-term digital averaging of the output for a fixed frequency. Means were also studied for obtaining the high precision required to measure an increase in concentration of a given neutral isotope above its natural background. Considerable emphasis was placed on a study of means for generation of microwave power in the region of millimeter wavelengths. Special sample cells, including a multiple reflection cell, were constructed for this study. These cells proved quite successful. The levels of microwave power obtained, however, appeared inadequate to take full advantage either of the higher absorption coefficients obtained in the high frequency region or of the longer absorption path length obtained by the use of the multiple reflection cell. Special techniques of sample preparation and conversion were studied with particular reference to compounds of biological interest (such as amino acids). In this connection the total oxidation or reduction of the sample in an rf discharge (in an atmosphere of oxygen or hydrogen respectively) appeared promising. A study was conducted of means for frequency control and stabilization. In this connection a special method was devised for provision of a stable baseline during a continuous frequency sweep. A design of spectrometer which appeared suitable for neutral isotope applications was formulated. This included provision for long-term digital averaging, an in-line reference cell for high precision of read-out, an out-of-line reference cell for frequency reference, and an automatic feedback loop for long-term frequency stabilization. (auth)

17912 (SC-TM-65-91) HIGH POWER ACOUSTOELECTRIC PULSE GENERATORS. Patterson, E. L. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1965. Contract AT(29-1)-789. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of a preliminary investigation into the use of explosively excited acoustoelectric generators are presented. An idealized model shows good qualitative agreement with experimental data if the double shock wave structure intrinsic to high

dynamic pressure is taken into account. 400 kW were radiated by a special antenna at 5 Mc. (auth)

17913 (SC-TM-65-515) ULTRASONIC BEHAVIOR OF INSTRUMENTATION CABLES. Arlowe, H. D. (Sandia Corp., Albuquerque, N. Mex.). Nov. 1965. Contract AT(29-1)-789. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Theoretical and measured data on the impedance and transfer properties of cables used for shock test instrumentation are presented. The data obtained provided means of defining the loads imposed on line-driving amplifiers and the line terminations required in the ultrasonic frequency region from 0.01 to 1 MHz. (auth)

17914 (SC-TM-67-30) PULSED CONSTANT CURRENT GENERATOR. Stephenson, W. A. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

It is a property of Manganin, as well as other metals, that its electrical resistance increases with an increase in hydrostatic pressure. In order to pursue studies involving the practical use of this phenomena as a shock wave pressure transducer, special instrumentation was developed. To observe the change in electrical resistance of Manganin when dynamic pressure is applied, it is necessary to either hold the voltage constant on a specimen and observe the change in current produced by the resistance change, or to maintain a constant current through the material and observe the voltage change across it. The instrument described is used to provide a pulse of known constant current simultaneously to three Manganin wire shock pressure transducers. (auth)

17915 (SCL-DR-66-110) QUARTZ CRYSTAL PRESSURE BAR TRANSDUCER WITH A TWO MICROSECOND RESPONSE. Thompson, R. A. (Sandia Corp., Livermore, Calif.). Mar. 1967. Contract AT(29-1)-789. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A 0.750 in. diameter thin quartz pressure bar transducer which was designed to measure rapidly varying pressures of 1000 to 50,000 psi with durations from 7 to 25 μsec is described. (auth)

17916 (TID-23746) AUTOMATICALLY CONVERTING A STANDARD NUMERICAL STRIP PRINTER SO AS TO COMBINE TWO-DIMENSIONAL PULSE ANALYZER INFORMATION INTO A CONVENIENT PAGE. Folsom, T. R.; Weitz, W. E.; Moore, J. M. (Scripps Institution of Oceanography, La Jolla, Calif.). Jan. 15, 1967. Contract AT(11-1)-34. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A new system is described that allows digital information in the memory matrix of a two-dimensional pulse height analyzer to be read out into a page that is convenient to study and file. The 4096 number matrix on this page, obtained automatically in about four minutes, permits immediate inspection of signal peaks so that effective programs can be selected for final analysis of the data by a computer. New mechanical and electrical accessories were devised for automatically cutting off and stapling together short strips of paper from a standard strip printer to produce a 11″ × 42″ page displaying a matrix of 4096 signal numbers and channel markers. This is easy to read, study, and display to an audience; it may be filed in a standard letterhead-size filing cabinet after folding. The new system is especially useful for study of arrays of very small numbers derived from measurements of very small traces of radionuclides. Cathode ray presentation then are generally not satisfactory. (auth)

17917 SECONDARY EMISSION OF AgMgOCs DYNODES AND ITS DEPENDENCE ON THE TEMPERATURE. de Munari, G. M. (Univ., Parma, Italy. Istituto Nazionale di Fisica Nucleare, Milan); Mambriani, G.; Giusiano, F. Rev. Sci. Instrum., 38: 551-3 (Apr. 1967).

A simple method for investigating the temperature dependence of the photomultiplier gain is described. The gain of the AgMgOCs dynodes of four 56AVP was measured as a function of the temperature between 90 and 300°K. The dynode gain was found to be independent of the temperature, at least within a few per cent. This ensures that the secondary emission, too, is constant within the above given temperature range. Moreover, the secondary emission as a function of the energy of bombarding electrons is temperature independent. (auth)

17918 MODULAR ELECTRONIC NUCLEAR INSTRUMENTATION. Vojinovic, Mirko (Boris Kidric Inst. for Nuclear Sciences, Belgrade). Nukl. Energ., 3: 18-22(1966). (In Slovak).

The needs for electronic nuclear instrumentation to be used for the measurement and analysis of electric signals emanating mostly from radiation detectors, are steadily increasing. The system of modular instruments provide an opportunity for the solution of many problems emerging during the development, production and use of nuclear instrumentation. The main activities on the development and production of electronic instrumentation in Yugoslavia are reviewed. (B.G.D.)

17919 NUCLEAR EQUIPMENT INDUSTRY IN HUNGARY. Energ. Nucl. (Paris), 8: 554-7(Dec. 1966). (In French).

The performances of certain apparatus: selective automatic energy integrators, one-way automatic amplitude analyser, and standard lead superstructure are analyzed. The author gives the technical characteristics and the use of each apparatus. (auth)

17920 MASS SPECTROSCOPY: AN OLD FIELD IN A NEW WORLD. Nier, Alfred O. (Univ. of Minnesota, Minneapolis). Amer. Sci., 54: 359-84(Dec. 1966).

An extensive review is presented on the theory, technic, instrumentation, and applications of mass spectroscopy. The following aspects are considered in particular: use of the instrument in gas analysis, leak detection, geochronology, age determination of the earth and solar system, examination of meteorites, xenology, molecular structure, studies, and space research. (TSS)

17921 UNIFORMLY VALID ASYMPTOTIC THEORY OF COLLISIONLESS ELECTROSTATIC PROBES. Bienkowski, George (Princeton Univ., N. J.). Phys. Fluids, 10: 675-8(Mar. 1967).

Extensions and corrections to Lam's theory of collisionless electrostatic probes are presented. A sheath is shown to exist for all finite potentials. The leading correction of $O'(h_e/R_p)^{\frac{1}{2}}$ to the saturation current is determined. (auth)

17922 NUCLEAR REACTOR PERIOD INSTRUMENTATION. Tanarro, Agustin (Junta de Energia Nuclear, Madrid). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 29-34(Jan.-Feb. 1967). (In Spanish).

Some particular aspects of period channels in nuclear reactor instrumentation are presented. A delayed anticoincidence system designed to improve operation safety and to decrease unwanted scram probability is described. (auth)

17923 LIVE-TIME AND HALF-LIFE CONTROL OF SCANNER FOR WHOLE-BODY RADIATION COUNTER. Sheen, E. M.; Palmer, H. E.; Stringer, J. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 13: 379-81 (Apr. 1967). (BNWL-SA-513).

A digital control system for whole-body scanning counters was developed to reduce error caused by either multichannel analyzer dead time or radionuclide decay during the scan. Live-time control is accomplished by operating the scanner with a stepping motor and reducing the input frequency directly with multichannel analyzer dead time. Reducing the frequency exponentially results in scanner velocity decay that follows the radionuclide decay to give a constant calibration during the scan. (auth)

17924 LOW FREQUENCY TIRISTOR SOURCE FOR NUCLEAR POWER PLANT CONTROL SYSTEMS. Lorkovic, Marijan (Elektrotehnicki Institut Poduzeca Rade Koncar, Zagreb). Nukl. Energ., 3: No. 5, 25-7(1966). (In Slovak).

The development of a cca 2 kW device for the generation of a low frequency ranging from 0 to 1.5 Hz is described. The device was developed under a contract entitled Development of a system for automatic operation of control rods in nuclear power plants, and it acts as a part of a frequency operated electrical motor. Particular attention was paid to the utilization of tiristors in such a device providing detailed description of the operation of a phase sensitive demodulator with tiristors. (B.G.D.)

17925 TRANSISTORIZED SIX-CHANNEL MONITORING DEVICE. Buerger, L.; Vajda, F. (Central Research Inst. for Physics, Budapest). Kernenergie, 9: 380-4(Dec. 1966). (In German).

A transistorized multichannel monitoring device TUDOR was developed. The device measures and indicates the pulses of both beta and gamma detectors and fast and thermal neutron detectors through 6 independent channels. The beta and gamma detectors may be connected to the device by a cable of max 1000 m of length, the neutron detectors by a cable up to 200 m of length. The counting rates are indicated logarithmically with constant statistical error in a range of 1 to 10^4 cps. Its multipurpose uses are realizable because of providing the device with a logic indicating and warning system. (auth)

17926 PRECISE NANOSECOND PULSE GENERATOR. Moszynski, Marek (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 11: 745-52(1966). (In Polish).

A precise nanosecond pulse generator worked out in the Physics Department of the Institute of Nuclear Research is presented. The

pulse is generated on the mercury relay. The generator gives positive and negative pulses with amplitude from 100 μV to 100 V. The stability of the amplitude is better than ±0.1% and the preciseness of amplitude calibration is ±0.2%. The rise time of pulses is shorter than 1 ns. The pulses are rectangular of width 5, 10, 20, and 50 ns or they have exponential falls with time constants 2 μs. The output resistance is 75 Ω. The pulse repetition frequency is 20 to 80 Hz. (auth)

17927 ECONOMY AND RELIABILITY IN NUCLEONIC INSTRUMENT DESIGN. Shepherd, B. (Isotope Developments Ltd., Eng.). Electron. Eng., 39: 100-5(Feb. 1967).

A series of instruments are described designed with value engineering applied to produce reliable but not expensive instruments. Novel circuits were employed in the design of a fast decade board with visual indication, a stable transformerless high voltage unit, and tunnel diode pulse height discriminators. (auth)

17928 SIMPLE PARTICLE IDENTIFIER. Chaminade, R.; Faivre, J. C.; Pain, J. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 49: 217-19(1967).

A good approximation of the particle identification formula: $(E\ \Delta E)^{\mu} - E^{\mu}$ is given. This has been used in a simple electronic circuit. (auth)

17929 A FAST COMPUTING CIRCUIT FOR PARTICLE IDENTIFICATION USING SIGNALS FROM A ΔE,E COUNTER TELESCOPE. Fisher, P. S.; Scott, D. K. (Oxford Univ.). Nucl. Instrum. Methods, 49: 301-8(1967).

A circuit is described which uses the natural characteristics of a field-effect transistor to form from the combined pulses of a solid state counter telescope, an analog signal characteristic of the incident particle type. The response is ideal in the sense that the device operates without adjustment over a wide energy range, and with ΔE counters of arbitrary thickness. (auth)

17930 STUDY OF THE EFFECT OF DEAD TIME ON MEASUREMENTS WITH A MULTICHANNEL ANALYZER. Dumazet, G.; Lambert, M.; Lefevre, G.; Picinbono, B. (Institut d'Etudes Nucleaires, Algiers). Nucl. Instrum. Methods, 49: 271-6(1967). (In French).

The dead time effects can be very important in the case of analysis by multichannel analyzers because of the complexity of the data processing. In the first part some of those effects on the counting rate of every channel is studied. The results are verified in an experiment with five channels with very different counting rate. A short discussion shows the limits of the theory and the new problems to be solved. (auth)

17931 Q-METER CIRCUIT FOR MEASUREMENT OF HIGH NUCLEAR POLARIZATION. Ryter, C. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 49: 267-70 (1967). (In French).

A Q-meter circuit specially designed for the measurement of high nuclear polarizations is described. An audio-frequency feedback circuit operates on the amplitude of the generator feeding the Q-meter and it is shown that the output voltage can be made proportional to the changes of the admittance $Y = Z^{-1}$ of the circuit. The result is that the resonance signal, instead of being of the form $X''/(1 + X'')$ as usual, is very nearly proportional to X''; $X'' = 4\pi\eta Q\chi''$ is proportional to the dissipative part of the high-frequency susceptibility. Detailed circuit diagrams are given; the operation of the circuit was tested by experiment. (auth)

17932 APPARATUS FOR THE IMPROVEMENT IN SIGNAL/NOISE RATIO FOR RECORDING MICRODENSITOMETERS. Frilley, M. (Institut du Radium, Paris). Nucl. Instrum. Methods, 49: 356-8(1967). (In French).

The described device drives the spectrum plate to be analyzed in an alternate movement perpendicular to the usual defiling translation. The signal to noise ratio is improved by a factor of 10 approximately. Matching this device on an existing microdensitometer does not lead to any transformation and allows numerical output facility for this equipment. (auth)

17933 INFLUENCE OF DIFFERENT PULSE-FORMERS ON THE EFFICIENCY OF ANTICOINCIDENCE-GATES. Polly, P. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Nucl. Instrum. Methods, 49: 341-5(1967).

Counting losses in the blocking pulse-former can severely impair the efficiency of an anticoincidence arrangement. Different pulse-formers are examined in respect to efficiency and their influence determined. A specific pulse-former which eliminates completely the additive terms in the anticoincidence rate, which occur with other pulse formers at high counting rates, is proposed. The specifications of the actually built instrument are given. (auth)

17934 MAGNETIC PRISM MASS SPECTROMETER. Kel'man, V. M.; Rodnikova, I. V.; Uteev, M. L. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 36: 2028-34(Nov. 1966). (In Russian).

A magnetic prism mass spectrometer is described. Collimation and focusing are accomplished by two identical 100-cm-focal-length singlet electrostatic lenses. The dimensions of the pole pieces of the magnetic prism, in which the beam is deflected through 106°, are 3 × 15 × 13 cm, and the gap between them is 16 mm. A beam of 4.0 to 4.2-keV ions from a conventional electron impact ion source is admitted through a 0.1-mm slit, limited by a 1.0 × 1.2-cm oval iris 88 cm from the slit, collimated by the electrostatic lens 12 cm from the iris, deflected by the magnetic prism, and focused by the second lens onto an adjustable slit having a maximum width of 0.35 mm. The current through the exit slit is amplified and recorded with an automatic plotter. The ion beam is brought to a line focus by the fringe field of the prism, and the focal line is in the central plane of the prism when the instrument is properly adjusted. This adjustment is effected by moving the prism magnet, because the collimator tube is rigidly fastened to the vacuum system. The relative mass dispersion of the instrument is 1330 mm (i.e., 13.3 mm per percent mass change). The records of several close mass doublets obtained with the instrument are presented. A resolving power of about 2200 was achieved with the exit slit wide open, and resolving powers up to 3000, with a narrow exit slit. Spectra were also recorded without the second (focusing) lens, the collimator being adjusted to overcollimate the beam and bring it to a focus on the exit slit. There was no appreciable deterioration of the resolving power under these conditions. (ATD)

17935 DYNAMICAL COMPUTATION OF PHOTON CORRELATIONS AND COUNTING STATISTICS. Korenman, Victor (Univ. of Maryland, College Park). Phys. Rev., 154: 1233-40(Feb. 25, 1967).

Equations of motion are derived for generating functions of field correlations and detector counting probabilities for an arbitrary system of electromagnetic fields in the presence of their sources. For a system with linear constitutive relations, the equations are solved exactly. Such systems are shown to be always Gaussian, and some representative counting distributions are computed. A perturbative treatment of a system with a cubic nonlinearity in its constitutive relation is made to find the counting distribution to first order in the nonlinear coefficient. A comparison is made with the below-threshold limit of a recent laser-fluctuation theory, and a possible application to measurement of phonon-phonon interactions is mentioned. (auth)

17936 ANODIZED ALUMINIUM OXIDE HYGROMETER. Somorjai, Endre. ATOMKI (At. Kut. Intez.) Kozlem., 8: 348-50 (Dec. 1966). (In Hungarian).

The working principle and preparation of anodized aluminum oxide probes usable for measuring the relative humidity of the insulating gas of a Van de Graaff generator are described. Simple calibration method is given. (auth)

17937 ANALOG INTEGRATOR. Toth, Ferenc; Tompa, Kalman. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 14: 409-13(1966). (In Hungarian).

The analog integrator developed for use with the "wide-line" nuclear magnetic resonance spectrometer of the Solid-State Physics Laboratory, which makes use of the EKMU NV-213-type linear programmer, is described. The application of the integrator permits a substantial improvement in the signal-to-noise ratio of the spectrometer. Some other possible uses of the integrator are suggested. (auth)

17938 TUNNEL DIODE PULSE SHAPE DISCRIMINATOR. Soucek, B.; Chase, R. L. (Brookhaven National Lab., Upton, N. Y.). Nucl. Instrum. Methods, 50: 71-6(1967).

A pulse shape discriminator is described which is suitable for neutron–gamma ray separation with several different detector types. It uses three tunnel diode discriminator circuits, one for setting an energy threshold, one for marking the leading edge of the input signals and one for marking their zero-crossover. The signal shape is characterized by the time from inception to zero-crossover, which is converted to a proportional output pulse amplitude. Measured signal width variations of ±2 nsec are observed with input signals varying from 50 mV to 5 V. (auth)

17939 DESIGN OF A FAST SIMPLE PULSE AMPLIFIER. Tojo, A. (Tokyo Univ.). Nucl. Instrum. Methods, 50: 45-9 (1967).

A fast simple pulse amplifier is presented. A gain of about 50 and a rise time of 3.2 ns are obtained with a three stage amplifier based on the proposed circuit layout employing transistors with f_T of 550 Mc. The analysis of the basic circuit and its optimization procedure when cascaded is given. The calculated

gain and the rise time of the circuit obtained by the analysis well agree with measured values. The circuit also shows a very good overload characteristic. (auth)

17940 CABLE CALIBRATOR (Engineering Materials). (California Univ., Livermore. Lawrence Radiation Lab.). (CAPE–1554).

9 drawings.

The system described is used in calibrating coaxial signal cables to 0.1 nanosecond relative accuracy. Shorted or open-ended cables can be calibrated using the appropriate pulser card. The system consists of a power supply, computer programmer, prescaler, two decade counters, and a pulser subtract. (For details see TID-4100 Suppl. 39.) (F.S.)

17941 100 kV IGNITION SWITCH (Engineering Materials). (Princeton Univ., N. J. Project Matterhorn). (CAPE–1555).

17 drawings.

Five standard ignitrons are operated in series to provide a reliable 100 kV switch which turns on in microseconds. The switch is useful in capacitor or delay line discharge circuit applications. The switch is capable of conducting tens of thousands of amperes, the limiting factor being ~250 C per pulse. (For details see TID-4100 Suppl. 39.) (F.S.)

17942 SINGLE-FIELD POLARIZING SPECTROPHOTOMETER FOR MEASURING MASS MOTION IN A PLASMA. Hirschberg, J. G. (to U. S. Atomic Energy Commission). U. S. Patent 3,316,412. Apr. 25, 1967.

The apparatus is described for measuring mass motion in a plasma by measuring the wavelength shift in an unpolarized beam of light directed across the plasma in a narrow range of wavelengths, wherein a monochromator transmits the light beam, a first refracting prism splits the beam into equal perpendicularly polarized rays, a refracting prism separates the polarized rays, and photosensitive means produces electrical signals corresponding to the wavelength shift in the beam in passing through the plasma. (AEC)

17943 ELECTRON PARAMAGNETIC RESONANCE SPECTROMETER FOR NUCLEAR REACTORS. Galland, Daniel; Santier, Christian; Servoz-Gavin, Pierre; Soutif, Michel (to Commissariat a l'Energie Atomique). British Patent 1,058, 562. Feb. 15, 1967. Priority date Oct. 22, 1963, France.

An electron paramagnetic resonance spectrometer, which is used for studying the effects of radiation on solids in an irradiation loop of a nuclear reactor, is described. (B.G.D.)

17944 TAIL PULSER (Engineering Materials). (Univ. of California, Livermore. Lawrence Radiation Lab.). (CAPE–1559).

30 drawings.

A tail pulser is described which is contained in a chassis with a 3½ in. front panel of standard 19 in. width with provisions for mounting in a relay rack. The unit's size and light weight (7 lbs) make it useful as a field instrument and its precision allows its use in a laboratory. The pulser consists of a multivibrator which opens and closes a switch in parallel with a capacitor, several stages of amplification for power gain and inversion, and a power supply. (For details see TID-4100 Suppl. 39.) (F.S.)

17945 COMPUTER CONTROL SYSTEM FOR DIFFRACTOMETER (Engineering Materials). (Univ. of California, Livermore. Lawrence Radiation Lab.). (CAPE–1548).

27 drawings.

An interface p is described which enables a Digital Equipment Corporation PDP-8 computer to control and collect data from a four circle goniometer used for single crystal x-ray diffraction studies. (For details see TID-4100 Suppl. 39.) (F.S.)

17946 ION TRAJECTORY STUDIES AND EXPERIMENTS FOR A QUADRUPOLE MASS SPECTROMETER. Powell, Homer Mitchell. Nashville, Vanderbilt Univ., 1966. 126p.

Thesis.

The predominating characteristics of the ion trajectories in a quadrupole mass spectrometer are determined. This is done by analytical study and is supported by certain experimental verifications using a quadrupole of modified design. The detailed characteristics of the trajectories are determined. The trajectories are basically sinusoidal, modulated accordingly for the x or y component trajectories and the system operating conditions. The experimental verifications are based upon this sinusoidal characteristic and the relationship of the trajectory period to the operating condition. As a result, it became apparent that a different type of quadrupole mass spectrometer possibly could be developed that would not have some of the objectionable features of the conventional quadrupole. The features of this modified quadrupole are evaluated as a result of attempting to verify the ion trajectories. Several approaches are presented for both the analysis and experiments. Analytical derivations, analog computer studies, and digital computer studies each give supporting evidence of the nature of the trajectories. Also several design approaches of the basic quadrupole system which make it possible to verify the ion trajectories are discussed. These are configurations of slits and wedges at the exit aperture of the quadrupole section and ion beam grating. Initially the basic characteristics of quadrupole mass spectrometers, their theoretical basis, and typical system design and construction are considered. The initial theoretical study involves an analog computer solution of the ion trajectories. The validity of these results is satisfied by comparing the trajectory amplitude to that obtained by other investigators using other methods. Due to the inherent instability of the governing equations, these solutions are limited to a study of conditions of low mass resolution. The results are useful however for interpretation of the trajectory characteristics. Due in part to the limitations of the analog results, an analytical derivation of the ion trajectories is made. In support of this, a study of the theory of Mathieu differential equations as it applies to a quadrupole is made. In view of their complexity, however, the analytical result does not lend itself to obvious interpretation. Thus the study is supplemented with digital computer solutions as a complementary approach and consequently may be used for the study of conditions of high mass resolution. In support of the experimental effort, a conventional quadrupole mass spectrometer was designed and built. This in turn was modified accordingly for the respective experiments. A comparison of theoretical and experimental results is graphically presented and interpretations made. With discrepancies adequately accounted for, a good comparison between theory and experiment is made. A quadrupole mass spectrometer of modified design which uses the same experimental techniques is proposed. The characteristics of this design and the corresponding advantages and disadvantages are discussed. Typical mass spectra are presented and evaluated. The basis for the departure from theory for the modified design is considered and suggestions made for possible improvements. (auth)

Radiation Effects on Instruments and Instrument Components

17947 EFFECT OF PULSED X-RAYS ON A BF_3 COUNTER. Fukuda, K.; Okabe, S.; Sato, Y. (Radiation Center of Osaka Prefecture). Nucl. Instrum. Methods, 50: 150-2(1967).

The operation of the BF_3 proportional counter under intense pulsed x-ray background was studied as a function of x-ray intensity and delay time from the x-ray pulse. A simple gating circuit was designed in order to overcome the overload of an amplifier system, which is caused by x-ray burst. Using this circuit, it was found that the x-ray burst causes a shift of pulse height distribution of BF_3 counter signals. This shift of pulse height distribution can be explained by the positive ion sheath developed around the center wire of the counter. (auth)

17948 INVESTIGATION OF THE INFRARED ABSORPTION SPECTRUM OF NEUTRON-IRRADIATED SILICON. Lotkova, E. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 37: 102-48(1966). (In Russian).

The infrared absorption spectrum of multicrystalline silicon, irradiated with fast reactor neutrons was investigated. The current theories on the effect of neutron irradiation on semiconductors were examined, and a review of the basic works on the effects of neutron irradiation on silicon was given. The methods used in the present study on neutron-irradiated silicon were described. The results showed that as a result of the irradiation, absorption bands, connected with the local level of the radiation detectors, appeared. The bands were tabulated and their origin was discussed. (J.S.R.)

17949 GALVANOMAGNETIC EFFECTS AND RELATED PHENOMENA IN SEMICONDUCTORS AND DIELECTRICS IN A RADIATION ENVIRONMENT. Meyer, LeRoy Carl. Albuquerque, N. Mex., Univ. of New Mexico, 1966. 178p.

Thesis.

Two sections are presented on the Hall effect and gamma radiation. The first part is entitled, Transient Radiation Effects on Hall Devices. The second part, entitled Magnetoconductivity in Dielectrics and Related Phenomenon in a Radiation Environment, applies to the Hall effect in the study of dielectrics in a radiation environment. In Part I a review of the basic theory of Hall effect and Hall effect devices as related to transient radiation effects is presented. The theory predicts that any transient effect in the Hall voltage output during gamma irradiation of the device depends on the type of biasing used. There is no change in Hall voltage output for constant voltage bias, but the Hall voltage varies as a function of 1/n for constant current bias, and as a

function of $|1\ \sqrt{n}|$ for constant power bias where n is the number of free electrons/cm^3 in the material. Equations were developed from four terminal network theory which show that the input and output impedance as well as the current gain also vary as a function of 1/n. The transient radiation effects are small and usually within the noise level for dose rates up to 10^8 R/sec. Some experimental data have been obtained using the AFWL 600-kV flash x-ray and WSMR gamma Linac that support the theory for dose rates up to 10^{10} R/sec. Both thin film and crystal devices are used. The thin film devices appear to have a wider range of frequency response and are more radiation resistant. In Part II some characteristics of dielectrics are reviewed and theoretical gamma radiation effects in connection with magnetoconductivity in polymers is presented. In addition, basic radiation effects measurements were made on polymer materials using the magnetoconductivity and Hall current measurements in a steady gamma flux. The polymers used were polyethylene, Teflon, and Mylar. (Dissertation Abstr.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 17564, 18013, 18015, 18018, 18019, 18055, 18061, 18084, 18121, and 18188.

17950 (DP-MS-66-12) CONCENTRATION OF ^{137}Cs, ^{65}Zn, AND ^{85}Sr BY FRESH-WATER ALGAE. Harvey, R. S. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.); Patrick, Ruth (Academy of Natural Sciences of Philadelphia, Pa.). Aug. 31, 1966. Contract AT(07-2)-1. 15p. (CONF-660907-10). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Chemical Society Meeting, New York.

Differences in the concentration and retention of ^{137}Cs by unicellular diatoms, filamentous green algae, and filamentous blue-green algae were demonstrated under both batch and continuous-flow culture conditions. Cesium-137 concentration factors were generally higher by a factor of 2 in batch tests than in continuous flow tests. In retention studies, ^{137}Cs was desorbed more rapidly from algae under continuous-flow conditions. Studies with blue-green algae indicate that ^{137}Cs concentrations in the various species were more closely related to the surface-to-volume ratios of algal cells than to the systematic relationships of the three species. Continuous-flow studies indicated no differences among three species of filamentous green algae in the concentration of ^{137}Cs, ^{65}Zn, and ^{85}Sr. However, the average concentration factors of the radionuclides were considerably different: 3800 for ^{65}Zn, 460 for ^{137}Cs, and 230 for ^{85}Sr. These radionuclides were rapidly desorbed following the transfer of algae to nonradioactive media. The desorption rate was inversely related to the concentration rate. (auth)

17951 (LF-33) SELECTIVE SUMMARY OF STUDIES ON THE FISSION PRODUCT INHALATION PROGRAM FROM JULY 1965 THROUGH JUNE 1966. Thomas, R. G. (ed.) (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.). Nov. 1966. Contract AT(29-2)-1013. 297p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies on the deposition, retention, translocation, and excretion of inhaled soluble and insoluble aerosols of ^{137}Cs or ^{90}Sr in dogs and rats and the biological parameters that are affected by inhaled radioactive materials. Data are included on the long-term effects of inhaled ^{131}I in rats and the effects of intravenously injected ^{131}I on the function of the thyroid and pituitary glands in rats. (C.H.)

17952 (NP-16646) UPTAKE OF RADIONUCLIDES BY PLANTS. Sartor, James D.; Lane, William B.; Allen, Jere J. (Stanford Research Inst., Menlo Park, Calif.). Dec. 1966. Contracts N228(62479)65703; NOO22866C0347. 261p.

The uptake of five radionuclides Sr-85, Zr-Nb-95, Ru-106, Cs-137, and Ce-144 was measured for seven plants bean, carrot, clover, lettuce, radish, tomato, and wheat grown in three different soil types sand, loam, and clay. Plants were grown in large soil containers that allowed most of the root system to develop under normal field conditions. Sampling started as soon as the plants sprouted and continued at frequent intervals depending on growth characteristics of the plant. Plant uptake contamination factors (a_{SU}) were calculated for each of the samples harvested. Comparisons of the uptake for various plant part-soil-radionuclide combinations at crop maturity show that the a_{SU} values for Sr-85 are the largest in all instances, usually by an order of magnitude. The a_{SU} value for the edible portion of each plant was lowest in every case, and usually the leafy portion of the plant had the largest a_{SU} value. (auth)

17953 (NYO-2085-10) STUDIES ON BIOLOGICALLY ACTIVE AMINES. Annual Progress Report, July 9, 1965–June 15, 1966. Kobayashi, Yutaka (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). June 15, 1966. Contract AT(30-1)-2085. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of studies on diamine oxidase and mammalian pregnancy are reported in published literature. A new method for assay of the enzyme catechol-o-methyltransferase is described. This enzyme is thought to be the major monoamine catabolizing enzyme in tissues other than the brain. The use of p-bis-(o-methylstyryl)benzene as a secondary fluor for liquid scintillation counting is reported. The counting efficiency is somewhat greater than that of dimethyl POPOP, the commonly used secondary fluor. Results of experiments on monoamine oxidase activity of rat brain and hypothalamus showed little or no difference 24 hours following x radiation. The effect of x radiation on rat stomach histidine decarboxylase was to cause a loss of enzyme activity in the soluble fraction S_2 and the appearance of the enzyme activity in the insoluble fraction, ND. The insoluble histidine decarboxylase was exposed to two proteolytic enzymes, papain and pepsin. Digestion with these enzymes did not result in the solubilization of insoluble histidine decarboxylase. Tables are presented to show histidine decarboxylase activity of the ND and S_2 fractions of stomachs from irradiated female and male rats. Hog kidney diamine oxidase was purified according to the procedure for hog intestine diamine oxidase; it was found that diamine oxidase from this source was also heterogeneous and thus similar to that in intestines. (H.L.W.)

17954 (NYO-3641-1) RADIATION CHEMICAL STUDIES ON HEMOCYANINS. Progress Report for Period January 1, 1966–October 1, 1966. Schubert, Jack (Pittsburgh Univ., Pa. Graduate School of Public Health). Oct. 15, 1966. Contract AT(30-1)-3641. 47p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Hemolymph was obtained from the marine invertebrates, Limulus and Busycotypus, and stored in the refrigerator. The refrigerator storage life of hemocyanin was 12 days. The criterion of deterioration was a time dependency of oxygenated and deoxygenated optical density. Samples of hemocyanin deteriorated after standing at room temperature for several hours. The irradiated samples deteriorated more slowly than the unirradiated samples. A higher bacterial count was found in the control samples than in the irradiated samples. The oxygen-carrying capacity of Limulus and Busycotypus hemocyanin decreased with increasing radiation doses up to a certain dose; very high doses regenerated the oxygen-carrying capacity. These effects were attributed largely to the dual nature of hydrogen peroxide, which oxidizes protein-bound copper at low peroxide concentrations and reduces oxidized copper at high peroxide concentrations. The ability of hemocyanin to decompose peroxide was relatively unaffected by irradiation. The catalase-like action of Busycotypus hemocyanin could be simulated by amino acid chelates of copper, including arginine, histidine, and glycine. Results of experiments on the effects of hydrogen peroxide on hemocyanin are shown by means of graphs. The shapes of the curves are similar to those obtained for the effects of radiation; however, the absolute values differ. It was interesting that regeneration of Busycotypus hemocyanin by hydrogen peroxide occurred, much as was observed with ionizing radiation. The catalytic decomposition of hydrogen peroxide by hemocyanin and copper chelates was studied. It was found that the catalase-like activity of Busycotypus hemocyanin was quite pronounced. Since other investigators have reported that the catalase-like action of hemocyanin was due to the presence of arginine in the molecule, a series of experiments were carried out using varying ratios of arginine to copper at different pH's. The results showed that copper-arginine chelates decomposed hydrogen peroxide. (H.L.W.)

17955 DEUTERIUM ISOTOPE EFFECT ON CARBON ISOTOPE FRACTIONATION IN PHOTOSYNTHESIS. Uphaus, Robert A.; Katz, Joseph J. (Argonne National Lab., Ill.). Science, 155: 324-5(Jan. 20, 1967).

Plants grown in D_2O showed a decreased tendency to fractionate carbon-13 during photosynthetic incorporation of carbon dioxide. The isotopic ratio $^{13}C/^{12}C$ of the tissues of deuterated plants appeared to be proportional to the deuterium content of the tissue. This effect was found in specimens of the partially deuterated vascular plant Nicotiana tabacum as well as in cultures of the fully deuterated alga Chlorella vulgaris. It was concluded that the change in fractionation shown by deuterated organisms was most likely a consequence of widespread changes in the cell; present data did not allow interpretation in terms of kinetic isotope effects on specific chemical reactions. (auth)

17956 METABOLISM OF 99m-PERTECHNETATE BY THE THYROID GLAND OF THE RAT. Socolow, Edward L.; Ingbar, Sidney H. (Boston City Hospital, Harvard Univ., Boston). Endocrinology, 80: 337-44(Feb. 1967).

The thyroidal metabolism of ^{99m}pertechnetate (TcO_4^-) was studied after administration of the isotope to rats in vivo or after incubation of excised rat thyroids with the isotope in vitro. In both types of experiment, thyroids actively concentrated TcO_4^-. Electrophoretic and chromatographic analyses of homogenates prepared from thyroids after exposure to the isotope revealed both free TcO_4^- identical in mobility to the original isotope, and a new immobile form of the isotope which remained at the origin (origin material, OM). Formation of OM was not inhibited by conventional doses of inhibitors of the organification of iodide, and OM often comprised as much as 70% of total accumulated technetium (Tc).

OM was resistant to digestion by Pronase and 6N HCl; exposure to 2N NaOH resulted only in the release of free TcO_4^-. Thyroid/medium (T/M) and thyroid/serum (T/S) concentration ratios for free TcO_4^- were increased by feeding low iodine diets or by chronic administration of propylthiouracil (PTU) in Purina Chow. Ratios were decreased by chronic thyroxine (T_4) administration, diets rich in iodine, incubation of excised thyroids in media enriched with stable iodide and by chronic administration of PTU in a low iodine diet. In all experiments, concentration ratios for free TcO_4^- were qualitatively similar to those expected if iodide were the substrate instead. In 2 studies in which concentration ratios for both $^{99m}TcO_4^-$ and $^{131}I^-$ were simultaneously determined, ratios of the T/M values for TcO_4^- and I^- were not constant and varied by as much as 50% in thyroids from animals of different experimental groups. It was concluded that measurements of TcO_4^- transport may be used as a qualitative, but not quantitative, index of alterations in the activity of the thyroidal iodide transport mechanism. In view of the invariable generation of a chromatographically and electrophoretically immobile product from free TcO_4^-, even qualitative studies require the application of separative techniques. (auth)

17957 RETENTION OF ^{85}Sr IN RATS. III. EFFECT OF INCREASING THE DOSES OF SODIUM AND BARIUM SULFATES AND ROLE OF THE TIME FACTOR. Volf, Vladimir; Roth, Zdenek (Inst. of Radiation Hygiene, Prague. Inst. of Industrial Hygiene and Occupational Diseases, Prague). Acta Radiol., Therapy, Phys., Biol., 4: 481-93(Dec. 1966).

Results of experiments indicated that sodium, magnesium, calcium, and barium sulfates were effective in minimizing the absorption of ^{85}Sr from the gastrointestinal tract in rats. The effectiveness of barium sulfate was increased by combining with sodium or magnesium sulfates. Reduction in the skeletal ^{85}Sr retention by more than 90%, in comparison with controls, was repeatedly observed in the experiments when treatment started 10 min after oral contamination. The difference in the retention between the treated and control groups did not change from the second to the eighth day, indicating that the treatment need not be repeated. All the agents were without effect when given 80 min after oral contamination with ^{85}Sr. (H.L.W.)

17958 STUDIES ON THE MECHANISM OF ACTION OF LIVER EXTRACTS IN INHIBITING UPTAKE OF ^{131}I IN VITRO BY THE RAT THYROID GLAND. Levey, Harold A. (State Univ. of New York, Brooklyn). Endocrinology, 80: 417-22(Mar. 1967).

The recently reported in vitro antithyroid action of various rat liver preparations was investigated further with a view to localizing the site of inhibition and ascertaining if liver extracts possessed a similar antithyroid action in vivo. Normal and goitrous rat thyroids were incubated in the presence of various concentrations of liver extract in a medium containing ^{131}I. The uptake of ^{131}I by the normal thyroids was greatly depressed by the liver extract, whereas the goitrous thyroids were relatively resistant to this suppressive action. Similar results were obtained with normal thyroids blocked in vitro by 1-methyl-2-mercaptoimidazole (Tapazole). The uptake of ^{131}I by the Tapazole-blocked thyroids was not further inhibited by the antithyroid liver principle. This was explained by the finding that the liver extracts exerted a selective inhibitory action on the formation of organic iodine compounds (determined as trichloroacetic acid-precipitable ^{131}I), in common with the action of propylthiouracil or Tapazole. Accordingly, once this process was blocked by Tapazole, the liver principle could produce no additional inhibitory effect. Samples of deionized liver extract (treated with the anion exchange resin Bio-Rad AG1-X8 and the cation exchange resin Bio-Rad AG50W-X8) were found to possess undiminished antithyroid activity in vitro. Thyroidal uptake of ^{131}I in vivo was moderately suppressed by iv infusion of extremely large quantities of liver extract. The release of ^{131}I in vivo from prelabeled thyroids was not affected by the liver extract. (auth)

17959 UPTAKE AND DISTRIBUTION OF EXOGENOUS TESTOSTERONE-1,2-^{3}H IN NEURAL AND GENITAL TISSUES OF THE CASTRATE GUINEA PIG. Resko, J. A.; Goy, R. W.; Phoenix, C. H. (Oregon Regional Primate Research Center, Beaverton). Endocrinology, 80: 490-8(Mar. 1967).

The amount of radioactive material recoverable from plasma, liver, hypothalamus, cerebellum, pituitary, prostate, and seminal vesicle was studied in 15 castrated guinea pigs killed ¼, 1, 4, 16 and 24 hr following injection of 43 μCi testosterone-1,2-^{3}H. The peak of radioactivity in plasma was at 1 hr for ether extracts and 4 hr for butanol extracts. In the liver, both extracts peaked at 1 hr. At all times more butanol-soluble radioactivity was found in liver than in plasma. In all other organs butanol extracts were lower than plasma values. These values may be underestimated since butanol extracts may not be completely soluble in scintillation fluid. Thin-layer chromatography separated ether extracts into predominantly 2 zones: Zone A radioactivity with mobility of testosterone, and Zone B with mobility of androstenedione. In 7 animals sacrificed 1 hr following injection, the concentration of Zone A radioactivity was significantly higher than plasma in hypothalamus, cerebellum and pituitary, not significantly different in prostate or seminal vesicle, and significantly lower than plasma in liver. Relationships were different for Zone B radioactivity. Concentrations of this labeled material were highest for prostate and seminal vesicle. Hypothalamus, cerebellum and pituitary, while containing significantly higher concentrations than plasma, were significantly lower than genital tract tissues. Liver and plasma did not differ significantly. Total body perfusion with saline at sacrifice did not alter the relationships between organs for Zone A and Zone B radioactivity. Recrystallization to constant specific activity and paper chromatography in systems designed to separate metabolites showed that Zone A radioactivity of hypothalamus was predominantly in the form of "free" testosterone. Zone B radioactivity from prostate and seminal vesicle contained appreciable amounts of both androstenedione and etiocholanolone. (auth)

17960 DETERMINATION OF BASE RATIOS IN SMALL SAMPLES OF RIBONUCLEIC ACID BY NEUTRON ACTIVATION PAPER CHROMATOGRAPHIC ANALYSIS. Flikke, Magne; Steinnes, Eiliv (National Inst. of Public Health, Oslo. Institutt for Atomenergi, Kjeller, Norway). Arch. Biochem. Biophys., 118: 82-4 (Jan. 1967).

Base ratios of very small samples of RNA were determined by a method involving alkaline hydrolysis of the RNA to monophosphonucleosides and electrophoretic separation of the components on paper at pH 3.5. The mononucleotide phosphorus was determined by neutron activation in a nuclear reactor with subsequent beta counting of the ^{32}P activity that was induced. This procedure was applied to samples containing only about one tenth of the amount of RNA required for an optical determination of base ratios. (auth)

17961 BIOCHEMICAL AND AUTORADIOGRAPHIC STUDIES ON THE RADIOSENSITIVITY OF VARIOUS PHASES OF THE MITOTIC CYCLE IN TUMOR CELLS. Maass, Heinrich; Schulz, K. D. (Univ., Hamburg). Geburtsh. Frauenheilk., 26: 761-4 (May 1966). (In German).

Following irradiation with 2000 to 5000 R of 200 KV x rays, cell division of one strain of Ehrlich ascites carcinoma cells was halted at the second rest phase following the DNA doubling time. Some cells were completely destroyed. The reason for the inhibition of cell division appeared to be either a blocking of the rest phase or of mitosis itself. After 1000-R irradiation the cell count was less strongly reduced, but the cell kinetics was normalized after a short time. This effect was less after 500-R irradiation. In a second, more resistant strain of the Ehrlich ascites carcinoma cells the number of cells doubled even after irradiation with a dose of 5000 R. After irradiation with a dose of 2000 to 5000 R, cell division was completely stopped for one generation, with some decrease in the number of cells. Because the cells involved were present in all phases of the generation cycle, blockage of cell division probably was due to blocking of the rest phase or of mitosis itself. In this strain of cells the inhibition became apparent only after the first generative cycle. When the dose was reduced to 500 or 1000 R, growth continued undisturbed for two generation cycle times. In the range of exposure from 1000 to 5000 R cell destruction was essentially independent of dose level. Measurements of the incorporation of ^{14}C- thymidine suggested that disturbance in DNA metabolism was not an important factor in the irradiation effects observed. Inhibition of DNA synthesis may have been due to the total effect of other reactions induced by the irradiation. (BBB)

17962 AN INTERPRETATION OF THE DEPENDENCE OF SPIN CONCENTRATION UPON RADIATION DOSE IN CRYSTALLIZED AMINO ACIDS. Sommermeyer, K.; Stegle, J.; Schnepel, G. H. (Univ., Freiburg i. B.). Atompraxis, 13: 20-4(Jan. 1967). (In German).

If crystallized substances are irradiated with high-energy x rays or uv, and the spin concentration is determined as a function of the dose, the result gives an exponential saturation curve. Experiments with x rays on the crystallized amino acid DL-valine have demonstrated that the exponential saturation curve is complex. This probably results from the joint action of the recombination of H atoms and radicals, and the recombination of radicals among themselves, or possibly also from a hitherto unknown process which leads to the destruction of the radicals. (auth)

17963 STUDY OF GRANULOPEXIS. II. THE SECOND PORTION OF THE CURVE OF BLOOD DISAPPEARANCE OF RADIOACTIVE GOLD COLLOID. Sicot, C.; Afifi, F.; Benhamou, J.-P.; Fauvert, R. (Hopital Beaujon, Clichy, France). Rev. Franc. Etud. Clin. Biol., 11: 707-9(Aug.-Sept. 1966). (In French).

A single intravenous injection of a colloidal preparation of ^{198}Au

was intravenously administered to rabbits and the disappearance of radioactivity in the blood was seen to consist of a rapid and slow phase. The slow phase accounted for only a small fraction of the total radioactivity. When plasma was administered to rabbits 24 hr postinjection, the disappearance of radioactivity in the blood also consisted of a rapid and slow phase. About 80% of the radioactive material disappeared during the slow phase. In plasma-injected animals, ^{198}Au content in the kidneys and urine was high; activity was very low in other areas of the body. In rabbits injected with ^{198}AuCl, disappearance of radioactivity in the blood was very slow; no hepatic fixation or urinary elimination occurred. Results seemed to indicate that the colloidal preparation of ^{198}Au did not contain particles: firstly, because this Au was not removed by organs containing reticulo-endothelial cells, as it was cleared by the kidneys and eliminated in the urine; secondly, because it was easily mobilized by a plasma transfusion. This behavior was similar to that of ^{198}AuCl i.e., slow disappearance from the blood with no hepatic fixation or urinary elimination. It was concluded that the available colloidal ^{198}Au preparation contained a small quantity of soluble ^{198}AuCl and that this accounted for the slow phase. (B.H.S.)

17964 EFFECT OF X-RAY IRRADIATION ON THE INTENSITY OF RADIOACTIVE METHIONINE INCORPORATION IN GASTRIC MUCOSA PROTEINS. Sukhomlinov, B. F.; Chaika, Ya. P. (Lvov State Univ.). Ukr. Biokhim. Zh., 38: 532-8 (1966). (In Ukrainian).

The effect of ionizing radiation on the electrophoretic characteristic and methionine-^{35}S incorporation was studied in various electrophoretic fractions of soluble gastric mucosa proteins. Rabbits served as experimental animals. Radioactive methionine was injected subcutaneously in dose of 120,000 pulses/min per g of live weight. The method of agar gel electrophoresis of soluble gastric mucosa proteins in intact animals revealed 13 fractions, which by their mobility in the electric field corresponds in the main to the serum proteins of rabbits. The predominant fractions moved at the rate of beta- and gamma-globulins and albumins. Ionizing radiation (dose 600 R) induces considerable qualitative and quantitative alterations in the electrophoretic spectrum of soluble gastric mucosa proteins. The changes in intensity of methionine-^{35}S incorporation in the various electrophoretic fractions of soluble gastric mucosa proteins indicate considerable disturbance of the biosynthesis of various fractions, particularly in the first period after ray lesion. (auth)

17965 STUDY OF NICOTINAMIDE METHYLATION IN LIVER SECTIONS OF RATS IRRADIATED WITH X RAYS. Zelinskii, V. G. (Pirogov Medical Inst., Odessa). Ukr. Biokhim. Zh., 38: 539-42(1966). (In Ukrainian).

Nicotinamide methylation was studied in surviving liver sections of rats sacrificed at various periods after irradiation with x rays (800 R). Methylation was judged by the formation of ^{1}N-methylnicotinamide. A rapid and durable depression of this process was established. Addition of ATP to the incubation mixture activates methylation in liver sections of the irradiated animals. Glutathione does not produce this effect. (auth)

17966 PRESENCE OF FREE RADICALS IN LASER-IRRADIATED BIOLOGICAL SPECIMENS BY ELECTRON-SPIN RESONANCE. Derr, V. E. (Martin Co., Orlando, Fla.); Klein, E.; Fine, S. Appl. Opt., 3: 786-7(June 1964).

Attempts were made to demonstrate free radicals in skin, liver, and enzyme preparations after ruby laser irradiation, in analogy to their presence in tissues subjected to x rays. In black mouse skin and hemolysin a high correlation was shown to exist between the observation of an electron-spin resonance (ESR) signal, and the irradiation and immediate freezing of the specimens. White mouse skin gave no ESR resonances, possibly because of lowered absorption. Collagenase gave no signal. Mouse liver, as expected, gave resonances whether or not irradiated. Visual observation of the samples indicated that the focused beam often produced much scattering of the material hit, and consequently signals were not observed in those samples of black skin hit by focused beams because the affected material was violently propelled away from the sample. Although the free radical content of the specimens of tissue did not deteriorate when kept at dry-ice temperature for one month, the signals from the hemolysin preparations became smaller, disappearing at the end of this time. It is concluded that free radicals are generated in black mouse skin and preparations of hemolysin by irradiation with ruby laser beams. (BBB)

17967 UPTAKE OF RADIO-STRONTIUM BY CEREALS FROM THE SOILS OF GEORGIAN SSR. Kvaratskhelia, N. T.; Arnautov, G. N. (Inst. of Soil Science, Agrochemistry, and Soil Conservation, Academy of Sciences, Georgian SSR). Pochvovedenie, No. 3, 110-15(Mar. 1967). (In Russian).

Strontium-90 uptake by oats and wheat dropped as the water solubility of strontium was decreased. A more effective method for producing a decrease in ^{90}Sr uptake was achieved by adding farm-manure and phosphorus fertilizers to the soil. The same effect was observed when lime was added to acid soils. Strontium-90 acquisition by plants decreased as the soil fertility and amount of plant nutrients in the soil was increased. (auth)

17968 ELECTRON SPIN RESONANCE OF TRIPLET STATES AND FREE RADICALS APPEARING IN PORPHYRINS, AROMATIC AMINO ACIDS AND PROTEINS UNDER THE EFFECT OF LIGHT. Azizova, O. A.; Gribova, Z. P.; Kayushin, L. P.; Pulatova, M. K. (Inst. of Biological Physics, Moscow). Photochem. Photobiol., 5: 763-70(Oct. 1966).

Electron paramagnetic resonance (EPR) of the triplet excited state of uv-irradiated solutions of a series of porphyrins and aromatic amino acids was studied. The porphyrins examined included etioporphyrin, Mg etioporphyrin, Hg complex of dimethyl ether of protoporphyrin IX, dimethyl ether of mesoporphyrin, tetraphenylporphyrin, Zn tetraphenylporphyrin, and chlorophyll B. Also studied were the aromatic amino acids tyrosine, tryptophan, and phenylalanine, and the dyes eosin, trypaflavine, acridine orange, and riboflavin. Frozen solutions (isopentane, ethanol, and water) were studied at 77°K under uv irradiation by a superhigh pressure Hg lamp. Triplet ESR absorption for transition $\Delta M = \pm 2$ was observed in fields of about 1500 G of porphyrins and chlorophyll B in a field of about 1650 G. In Mg-etioporphyrin absorption with $\Delta M = \pm 1$ was observed additional to those with $\Delta M = \pm 2$. During illumination with the full light spectrum of the Hg lamp, intensive ESR absorption caused by a triplet excited state of a chromophore appears at first. After that the rapid decrease of the concentration of triplet-excited molecules with simultaneous (corresponding to the fall of triplet-excited molecule concentration) accumulation of free radicals of chromophore and matrix was observed. Thus, photoreactions in solid solutions of porphyrins and aromatic amino acids proceed through the triplet excited state. Reactions of photosensitized deamination of aliphatic amino acids in solid aqueous solutions at 77°K by aromatic compounds were studied. (BBB)

17969 CHANGES IN ELECTRON MICROSCOPIC SECTIONS BY DECREASING ELECTRON BEAM AND ON THE STRUCTURE OF IMBEDDED TISSUES. Lippert, W. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Z. Naturforsch., 20b: 775-8(Aug. 1965). (In German).

Radiation-induced changes in the imbedding material and in the biological material itself can affect contrast alterations in sections viewed by electron microscopy. These changes occur in two different ranges of objective thickness and thus each can be ascertained separately. The new imbedding materials demonstrate contrast changes in the range of 10^{-3} to 10^{-1} c/cm^2. For biological structures the range is ~3 orders of magnitude greater. These differences were measured and compared for aldehyde fixation and for embedding in Vestopal W or Araldit (Durcupan ACM). At lower object current density there is a pure radiation effect that causes changes in interatomic bonds and thus to losses of material. Methylacrylate loses a maximum of ~⅔, Vestopal W and Durcupan ACM ~⅓, at most. A second effect of the electron beam in the stabilization of the objective against thermal effects. For this a somewhat higher density is needed. The third effect that is produced is thermal. It depends on the object carrier and the preirradiation of the object. By suitable use of the thermal effect the embedding material can be practially completely protected against radiation. The prerequisite for preparation of the embedding material for a thermally stable section by means of the pure radiation effect is that it is irradiated with a current density so small that no thermal effect appears, and long enough so that the charge density directed toward the object is sufficient to stabilize it. In order to obtain the greatest thermal effects, the material must be irradiated as fast as possible most intensively without destroying biological structure. Changes in the cellular elements are more difficult to study, because the current density cannot be made small enough. The negative contrast between chromatin and nucleoli and the apparently physically caused coloration of the nucleic acid cell components by the negative staining method are discussed. (BBB)

17970 BIOCHEMICAL RADIOSENSITIVITY OF LYMPHOID TUMORS. Klouwen, H. M.; Appelman, A. W. M. (Radiobiological Inst. TNO, Rijswijk, Netherlands). Cancer Res., 27: 255-60 (Feb. 1967).

The effect of whole-body x irradiation on rat thymus, 3 different mouse lymphosarcomas, and a mouse myeloid leukemia were studied. In thymus, myeloid leukemia, and C57BL-lymphosarcoma, the inhibition of nuclear adenosine-5′-triphosphate (ATP) synthesis and mitochondrial oxidative phosphorylation is demonstrated within a few hr after irradiation. The inhibition of nuclear ATP synthesis precedes the decrease of weight of the tissues, and of the DNA and ATP content of the nuclei after irradiation. In the F_1- and CBA-lymphosarcoma, inhibition of nuclear ATP synthesis is much more delayed and no inhibition of mitochondrial oxidative phosphorylation

is observed at the time when nuclear ATP synthesis is inhibited 50%. The cells which show the early inhibition of nuclear and mitochondrial ATP synthesis die exclusively or predominantly in interphase while the more radioresistant lymphoma cells (F_1 and CBA) die in reappearing mitosis. A biochemical mechanism for radiation-induced cell death is proposed. (auth)

17971 CHANGES IN LIVER COMPONENTS INDUCED BY FRACTIONATED DOSES OF X RAYS. Angelico, R.; Casparrini, G.; Misiti, P.; Moretta, L. (Istituto Superiore di Sanita, Rome). Boll. Soc. Ital. Biol. Sper., 42: 113-16(Feb. 15, 1966). (In Italian)

Biochemical determinations of liver constituents were made in male, Long-Evans rats weighing 170 g submitted to daily whole-body 50-R doses of x rays (220 kv). The total doses in the four groups of rats studied reached 1300, 1800, 2300, or 3000. Subgroups of rats subsisted on a basal diet, a diet supplemented with 3% lipoic acid, and one supplemented with 0.6% methionine (both added as liver protectants). Rats on the basal diet receiving a total dose of 1800 R showed a 3½-fold increase in liver glycogen; this increase was less in rats on the other two diets. Total lipids in liver were increased in the 1300-R group but became near-normal after a total dose of 1800 R. In general, triglycerides declined slightly in liver of irradiated animals. Serum total lipids rose while serum triglycerides tended to decline after the higher doses of radiation. Carcass lipids rose. Some effect of lipoic acid and methionine supplementation was seen in all dose groups on survival rate. For example, after an accumulated dose of 1800 R, 65% of rats on the basal diet survived compared with 86 and 77% on the lipoic acid and methionine supplements. (BBB)

17972 COMPARATIVE EFFECTS OF CYCLOPHOSPHAMIDE AND TOTAL-BODY IRRADIATION ON ERYTHROPOIETIN PRODUCTION IN RATS. Hoest, Herman; Skjaelaaen, Peer (Norsk Hydro's Inst. for Cancer Research, Oslo). Scan. J. Haematol., 3: 154-7(1966).

At different time intervals after treatment, x-irradiated (300 or 500 R) and cyclophosphamide-treated rats were exposed to hypoxia for 8½ hr to stimulate erythropoietin production, by placing the animals in a chamber containing 10% oxygen and 90% nitrogen. Erythropoietin levels were measured by injection into polycythemic mice of the pooled rat plasma samples and the effect on the 72-hr ^{59}Fe incorporation into the red cells of the polycythemic mice was studied. Such exposure of normal rats to hypoxia for 8½ hr increased the erythropoietin content in plasma to about three times the pretreatment levels. No consistent trend in the pattern of erythropoietin response to cyclophosphamide and irradiation was seen. A reduced erythropoietin response was observed at Day 1 after cyclophosphamide treatment and at Day 42 after irradiation. At the intermediate days the titers were above those in untreated rats exposed to hypoxia. The results suggest that sublethal doses of whole-body irradiation or cyclophosphamide do not affect the erythropoietin production in rats. The disagreements between the present results and those reported earlier by Fisher seem to be related to the different doses employed. In the latter studies a reduced erythropoietin production was observed following exposure of the exteriorized kidney to 3600 R or following isolated perfusion of the kidney with heavy doses of drugs. (BBB)

17973 PHARMACOLOGICAL MODIFICATION OF HEPATO-ENTERAL STRONTIUM TRANSFER. Gutschow, K.; Schmid, A. (Institut fuer Pharmkologie, Toxikologie, und Pharmazie, Munich). Arch. Pharmakol. Exp. Pathol., 255: 19-20(1966). (In German).

Adult male rats were subcutaneously injected with a mixture of 0.12% $SrCl_2$ and 5.5% glucose after a 15-hr withdrawal of food. Bile was collected hourly by way of a bile duct fistula, and the amounts of Sr determined by flame photometry. These results were compared with those obtained after the excretion of Sr into bile following injection of several chloretics and substances known to have an affinity for Sr. The hepato-enteral flow of Sr was increased by 1-phenylpropanol, d-penicillamine, thioctic acid, bromophthalein, and succinyl-mono-α(2,5-endomethylene-cyclohexyl)-ethyl ester. The Sr concentration of the bile was increased by d-penicillamine, thioctic acid, and promophthalein, and Sr excretion was enhanced by increased biliary flow when dehydrochloric acid, 1-phenylpropanol, and succinyl-mono-α(2,5-endomethylene-cyclohexyl)-ethyl ester were used. (BBB)

17974 EFFECT OF X-IRRADIATION ON RAT THYMOCYTES IN VITRO. Chang, Yung-lien; Shen, Tsung-lu; Chang, Yu-tuan (Inst. of Biochemistry, Shanghai). Sheng Wu Hua Hsueh Yu Sheng Wu Wu Li Hsueh Pao, 6: 239-48(June 1966). (In Chinese).

A suspension of rat thymocytes was maintained in vitro for more than 12 hours with reasonably good survival. By vital staining with erythrosin and examination of fixed film preparations stained with haematoxylin, the response of thymus lymphocytes to various physical and chemical factors such as heat, KCN were determined. The susceptibility of deoxyribonucleoprotein (DNP) of thymocytes to treatment with phenol and sodium trichloroacetate was found to be similar to that of thymus tissue. Thymocytes maintained in vitro were very sensitive to X-irradiation, as reflected by the significant increase in percentage values of both erythrosin-stainable cells and pycnotic cells after radiation. The former at 6 hours post irradiation was shown to rise steadily as the dose was increased from 50 to 10,000 R, while the pycnotic counts increased more sharply with dose and reached a maximum at a dose of 500 R. DNP became more labile and the extraction yields of DNA with phenol and sodium trichloroacetate (either 1.0% or 1.5%) also increased steadily with time of incubation in contrast to those of control non-irradiated cells which remained constant throughout the experiment. Exceptionally large doses, such as 10,000 R, were found to have a fixing effect that resulted in no change in extractable yields of DNA. Results were interpreted as agreeing fairly well with those obtained with in vivo x radiation and indicated that changes in the extractability of DNA with sodium trichloroacetate and phenol may be the direct result of irradiation damage on thymocytes. The effect was not considered a primary event since the changes observed were closely related to changes in cell population. (JPRS)

17975 LASER EFFECT ON DENTAL HARD SUBSTANCES: MICROSCOPIC STUDIES. Schulte, W.; Klaus, H. D.; Flach, A.; Geisbe, H. (Univ., Tuebingen, Ger.). Deut. Zahnaerztl. Z., 20: 289-301(Apr. 1965).

Healthy enamel, dentin, various carious defects, and old fillings of extracted human teeth were irradiated with a ruby laser. The focal point measured 0.2 and 1 mm in dia and the frequency of the impulses was up to 15 per sec with an initial energy of 2.4 W/sec per impulse. Impressions were taken from the target area and ground sections were made. In healthy enamel and dentin the laser beam caused defects which were similar to the ones drilled with a regular burr. Carious material was selectively removed, and significantly smaller amount of energy was needed than for healthy dental hard substances. Old fillings could also be removed with the laser beam. Results are evaluated from details on microphotographs and discussed in regard to possible therapeutic uses of the laser in dentistry. (BBB)

17976 CLINICO-RADIOLOGIC CONSIDERATIONS ON A CASE OF BERYLLIOSIS. Mannino, N.; Viterbo, F. (Univ., Bari, Italy). Quad. Radiol., 30: 789-96(July-Aug. 1965). (In Italian).

A 59-yr-old man was occupationally exposed to beryllium from 1949 to 1960. In 1952 he was first hospitalized for acute respiratory symptoms which progressed rapidly. In 1956 he had to stop working because of a new episode of respiratory insufficiency, manifested by dyspnea. At this time Be was detected in his urine at a concentration of 0.32 μg/l and in 1964 a lung radiograph was made; nodular shadows of symmetrical distribution were seen in the lower portion of the lungs. Chronic pulmonary berylliosis was diagnosed on the basis of these findings. In 1964 intensive studies were made of his condition; results of various tests are given. Differential diagnosis of pulmonary berylliosis is discussed. A review of the literature revealed that tests for Be in the urine were positive in about 50% of the cases tested and that ~15% of cases tested for Be in blood were positive. Medicolegal aspects of the disease are also considered. (BBB)

17977 LASER ACTION AT THE CELLULAR LEVEL. Goldman, Leon; Rockwell, R. James (Univ. of Cincinnati). J. Amer. Med. Ass., 198: 641-4(Nov. 7, 1966).

Laser action in animal tissues is described in terms of four separate phases of interaction that occur in the impact area. The most important phase was listed as the thermal component of the laser reaction and was described as a nearly adiabatic process in which the laser energy is transformed through multiple absorption processes into heat. In the next phase of the laser action, the elastic stress (ultrasonic) wave and recoil pressure wave were calculated to exceed thousands of atmospheres. The third phase of laser action at the cellular level was described as consisting of those changes which result from the interaction of the enormous electromagnetic fields associated with the laser beam; these are of the order of magnitude of binding forces which hold atoms together, and therefore produce free electrons, ionized atoms and molecules. This process that results when a bound electron, under the force of a strong external electric field, has broken its electrostatic potential barrier was denoted as field-stripping. The significant gross changes in transparent tissues after irradiation by the laser, and enzymatic and cytological changes that occur in tissues are described and discussed. The gross and histological results of the interaction of the laser energy with biological specimens are also described. Applications of lasers in clinical research and therapy are discussed. (BBB)

17978 HIDDEN DAMAGE IN CALF THYMUS DNA PRODUCED BY X-RAY IRRADIATION. Li, Tsai-ping; Ching, Pei;

Lu, Hsin-fa; Chien, Hsiao-chen (Inst. of Biochemistry, Shanghai). Sheng Wu Hua Hsueh Yu Sheng Wu Wu Li Hsueh Pao, 1: 26-40(Aug. 1961). (In Chinese).

The effect of x radiation in the presence of oxygen on the molecular structure of calf thymus DNA was studied. The reduced viscosity (RV) was decreased and the molar extinction coefficient (MEC) increased with increases in x ray dosage at a definite dose rate. Other than these apparent effects, there were, as deduced from studies on heat-lability, also hidden damages in the DNA macromolecule, even with doses as low as 1×10^4 R. While RV and MEC of the unirradiated DNA remained unchanged after incubation in 0.2M NaCl at 76°C for 60 min, the irradiated DNA upon incubation showed further decreases in RV and increases in MEC. This decrease in stability of irradiated DNA to heat revealed that, in addition to the disruption of some of the hydrogen bonds in DNA immediately upon irradiation, a labilization of other hydrogen bonds also occurred. A protective agent, probably calcium citrate, was found to be present in the stock solution of DNA. In the presence of this compound, the RV of DNA remained constant after 6×10^4 R x radiation and decreased slightly after 12×10^4 R x radiation, with no significant changes in MEC. The mechanism of the action of calcium citrate as a radioprotective agent for DNA and the significance of the hidden damage of the DNA macromolecule in the primary and cumulative biological effects of radiation are discussed. (JPRS)

17979 THE EFFECT OF VARIOUS DIETARY CALCIUM LEVELS ON THE ELIMINATION OF ^{89}Sr. Creger, C. R.; Colvin, L. B.; Couch, J. R.; Ansari, M. N. A. (Texas A and M Univ., College Station). Health Phys., 13: 401-4(Apr. 1967).

Data were collected from male chicks injected with 14.4 μCi of ^{89}Sr and fed diets containing 1, 2 and 3 percent Ca. Four bones and twelve soft tissues were taken at 2, 4, 8 and 12 weeks post-injection time and analyzed for ^{89}Sr content by liquid scintillation spectroscopy; data were calculated by the IBM 7094. The calculation of "elimination constants" (λ) from these data indicate that the elimination of ^{89}Sr from the bone can be accelerated by a factor of 4 if the dietary level of Ca is increased from 1 to 3 per cent. Of the soft tissues taken for analysis, only eyes showed appreciable activity. The eyes were observed to accumulate increasing amounts of ^{89}Sr activity as the experimental period progressed. Such accumulation of ^{89}Sr by the eyes was found to be increased by increasing the dietary Ca level. (auth)

17980 THE EFFECT OF CHRONIC VIBRATION ON ^{32}P PHOSPHORUS TURNOVER IN THE CENTRAL NERVOUS SYSTEM. Jurczak, Marek. Acta Physiol. Pol., 17: 743-53(Sept.-Dec. 1966). (In Polish).

After exposure to vibration for one day a rapid rise in the ^{32}P turnover rate was observed in the lipid and nucleoprotein fractions of the central nervous system. After 3 days' exposure to vibration the ^{32}P turnover rate was diminished, although still considerably higher than in the control group of animals. After 6 days' vibration a marked drop occurred to levels below the control group, accompanied by morphologic changes in the central nervous system. After a 10-day pause following 6 days' vibration no morphologic changes and normal ^{32}P turnover were observed. It was concluded that the morphologic changes as well as the changes in ^{32}P in the lipid and nucleoprotein fractions are transient. Disorders in cellular biochemistry preceded the appearance of the morphologic changes in the central nervous system. (auth)

17981 METABOLISM OF ^{137}Cs IN THE ANIMAL BODY. Derecki, Juliusz. Acta Physiol. Pol., 15: 755-61(Sept.-Dec. 1966). (In Polish).

Metabolism of ^{137}Cs was studied in rats in the early stage following subcutaneous contamination. The experiments were performed with 40 rats, divided into 4 groups of 10 animals each. Distribution in the tissues and excretion during the first four days after contamination were investigated. Tissue levels of ^{137}Cs were assayed by a radiochemical method, and activity of the whole body and excretions by direct measurement of gamma radiation by means of a scintillation crystal. Dynamic curves of levels of the radionuclide in different organs and curves of its retention and excretion are presented. A different behavior of ^{137}Cs in the skeletal muscles was noted compared with the heart muscle and other tissues. The results of measurements of retention and excretion were discordant. Global activity of excretions was very low, presumably as a result of losses when collecting the material. It was concluded that measurements of whole-body activity are more reliable than measurements of activity of the excretions. (auth)

17982 SECRETION OF THE ^{131}I-ALBUMIN TO THE GASTRIC JUICE IN PATIENTS WITH GASTRIC CARCINOMA. Sznapka, Zbigniew; Szybinski, Zbigniew; Horzela, Tadeusz. Nowotwory, 16: 335-8(Oct.-Dec. 1966). (In Polish).

The disappearance of ^{131}I-albumin from the blood and secretion of this isotope indicator to the gastric juice was investigated in 19 patients with gastric carcinoma and in 14 healthy people. The disappearance of the ^{131}I-albumin from the blood of patients with gastric carcinoma is the same as in healthy people. After 24 hours the activity of the plasma is approximately half the initial value. The activity of the gastric juice is higher in patients with gastric carcinoma: it depends solely on the free iodine and on iodine from compounds passing through the semipermeable membrane. (auth)

17983 INVESTIGATIONS ON THE KINETICS OF ^{59}Fe AND ERYTHROKINETICS OF ^{51}Cr IN CHRONIC LYMPHATIC LEUKEMIAS. Pawelski, Slawomir; Konopka, Lech; Rechowicz, Krzysztof; Darocha, Tadeusz. Nowotwory, 16: 343-8(Oct.-Dec. 1966). (In Polish).

Clinical hematological and isotopic (kinetics of radioactive ^{59}Fe and erythrokinetic of ^{51}Cr) investigations in 15 cases of anemia accompanying chronic lymphatic leukemias are used to show the complicated mechanism of existing anemia. The main role in the pathogenesis of the anemia involves disturbances of erythropoiesis under the form of ineffective erythropoiesis. In half the observed cases hemolytic syndrome was present which in majority of patients had a latent course. In a majority of cases even when an increase of effective erythropoiesis and of the synthesis of hemoglobin was present, hemolysis was dominating, resulting in negative daily balance of hemoglobin. (auth)

17984 Cis-syn THYMINE HOMODIMER FROM ULTRAVIOLET IRRADIATED CALF THYMUS DNA. Varghese, A. J.; Wang, S. Y. (Johns Hopkins Univ., Baltimore). Nature, 213: 909-10 (Mar. 4, 1967). (NYO-2798-21).

The cis-syn thymine homodimer (T = T) was identified as one of the products formed by uv-irradiation of calf thymus DNA. Because the isolation procedure involves acid hydrolysis, it has yet to be shown that T = T is a photoproduct formed directly upon irradiation. Direct formation of T = T did not involve the 5-methyl group, as previously shown. Therefore, it is suggested that T = T formation on cellular DNA requires at least one intermediate step. It is emphasized that the principal product of uv-irradiated DNA consists of at least one other compound that is chromatographically indistinguishable and co-crystallizable with T = T, although it is not that compound. (H.G.D.)

17985 FACTORS INFLUENCING RADIOSTRONTIUM ACCUMULATION IN DAPHNIA. Porcella, Donald B.; Rixford, Charles E.; Slater, John V. (Univ. of California, Berkeley). Health Phys., 13: 391-9(Apr. 1967).

Strontium and calcium relationships were measured in populations of Daphnia magna to determine some of the factors which affect Sr accumulation. The Ca and Sr in Daphnia is a function of the size of the Daphnia and the Ca^{2+} concentration in the water. Although growth and size cannot be considered independently of feeding, the equilibrium concentration of Ca and Sr is not affected by the food chain. Strontium-85 accumulation follows first order reaction kinetics and in populations consisting of mixed sizes, both uptake and release follow first order reaction kinetics. Reaction rates are a function of size in populations and smaller organisms appeared to reach equilibrium before larger organisms. This appears to be due to the fact that Ca and Sr are accumulated mostly in the carapace and hence ^{85}Sr uptake is a function of the population molting rate. An expression is given, treating the discrimination factor K_d^{Sr} as a constant, which gave reasonable agreement with the observed data. It appears to be possible to determine the population rate of growth in Daphnia by determining the rate of uptake of ^{85}Sr. (auth)

17986 MOLECULAR MECHANISMS OF REACTIVATION AFTER RADIATION DAMAGE. Val'dshtein, E. A.; Zhestyanikov, V. D. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 1-20 (Jan. 1967). (In Russian).

Contemporary concepts concerning molecular mechanisms of photo- and dark reactivation of cells and their components irradiated with uv light are presented. Reparation mechanisms of various radiation and non-radiation damages, such as, ionizing radiation of various density, ^{32}P transmutations, photodynamic effects, chemical mutagens and radiomimetic substances are discussed. The biological role and specificity of the dark reactivation mechanism are considered. (auth)

17987 SKIN CONTAMINATION BY RADIOISOTOPES. IV. PIG SKIN CONTAMINATION BY ^{35}S, ^{125}Sb, ^{147}Pm, ^{204}Tl, AND ^{210}Po. Tashiro, Shingo (Japan Atomic Energy Research Inst., Tokyo); Wadachi, Yoshiki; Muramatsu, Mitsuo. Nippon Genshiryoku Gakkaishi, 8: 642-4(Dec. 1966). (In Japanese).

Experiments were carried out to determine the surface and interior contaminations in layers of fresh pig skin that had been soiled with ^{35}S, ^{125}Sb, ^{147}Pm, ^{204}Tl, and ^{210}Po solutions of various acidities for various periods of soiling time. It was proved that

Tl^+ is cationic, $S(SO_4^{2-})$ is anionic and Sb^{3+}, Pm^{3+}, Po^{4+} are radiocolloidal in their mode and character of skin contaminability. The latter three showed distinctive skin contaminations in the acidity regions for radiocolloidal formation. It was found that interior contamination was almost negligible, regardless of contaminant species, acidity, or soiling time. (auth)

17988 RADIOSTRONTIUM EXCRETION IN THE FECES OF YOUNG RATS AFTER CALCIUM-RICH DIET. Pany, J. E. (Univ., Vienna). Experientia, 23: 146(Feb. 15, 1967). (In German).

Young immature rats of both sexes were fed with a diet either high (1.95%) or low (0.31%) in Ca content. A s.c. injection of weightless ^{90}Sr results in a better excretion of radiostrontium with the feces during feeding with high Ca diet. The retention of activity in the femori 30 days after injection is, in the same case, lower than by feeding with low Ca diet. (auth)

17989 INFLUENCE OF SODIUM CARBONATE ON THE UPTAKE OF ^{32}P BY GROUNDNUT PLANTS. Reddy, M. Sanjiva; Rao, G. Rajeswara (Sri Venkateswara Univ., Tirupati, India). Curr. Sci. (India), 36: 161-2(Mar. 20, 1967).

A 0.2% Na_2CO_3 concentration in the soil of groundnut plants for one week inhibited the later uptake of phosphorus by the plants. Acid-soluble and acid-insoluble phosphorus fractions were affected to about the same extent. It is concluded that phosphate metabolism is affected due to salt injury. (C.O.)

17990 RELATIONSHIP BETWEEN INGESTION, EXCRETION, AND ACCUMULATION OF FALLOUT ^{137}Cs IN MAN ON A LONG-TERM SCALE. Fujita, M.; Yabe, A.; Akaishi, J.; Ohtani, S. (Japan Atomic Energy Research Inst., Tokyo). Health Phys., 12: 1649-53(Dec. 1966).

Investigations were made to follow the ingestion, excretion and accumulation of fallout ^{137}Cs in five volunteers on a long-term scale, and, at the same time, using the data so obtained to determine the biological half-life of Cs as well as the fraction of this nuclide in urine of that in total excreta. The dietary intake, daily excretion and body of ^{137}Cs increased since 1962 to the maxima in the middle of 1964, but thereafter the levels began to decrease. The relationship between the body burden and the total excretion indicated biological half-lives of from 57 to 138 days. The mean value was 80 days. It was noticed that the biological half-lives varied somewhat between and for the same individuals. Urinary excretion divided by total excreta ranged from 0.74 to 0.91, and the mean value was 0.86 in the subjects. The corresponding values for K are also studied and they are compared with those for ^{137}Cs. (auth)

17991 PREDICTING THE TOTAL INTAKE OF RADIOIODINE OF HUMANS CONSUMING GOATS' MILK. Lengemann, F. W.; Wentworth, R. A. (New York State Veterinary Coll., Ithaca). Contracts AT(30-1)-2147; 12-14-100-5779(44). Health Phys., 12: 1655-9(Dec. 1966).

This paper presents data obtained when fourteen goats were given radioiodine daily for periods up to 25 days. An equation was developed from this data that expressed the concentration of radioiodine in milk with time, accounting for such factors as radioactive decay, pasture losses, time from production to consumption and volume of milk consumed. Integration of the modified equation from zero to infinte time produced an estimate of the total projected intake. This total intake value was then divided by the concentration of radioiodine in milk at each day after the start of ingestion of radioiodine by the goats to produce a series of ratios. These ratios can then be applied in a practical situation to predict total intake of radioiodine by humans following a single deposition of ^{131}I if the concentration of radioiodine in a milk sample and the time of production of that milk sample is known. (auth)

17992 EFFECT OF VARIOUS SUBSTANCES ON SECRETION OF RADIOSTRONTIUM INTO MILK. Comar, C. L.; Wasserman, R. H.; Twardock, A. R.; Lengemann, F. W. (New York State Veterinary Coll., Ithaca). Health Phys., 12: 1661-9(Dec. 1966).

The secretion of chronically ingested radiostrontium into the milk of cows and goats as affected by various treatments has been studied. Short-term effects are indicated by changes in the radiostrontium concentration in milk; long-term effects can be predicted from changes in values of $OR_{milk/diet}$ [(Sr*/Ca* of milk)/(Sr*/Ca* of diet)] as determined by double tracer methods. Addition of NaEDTA, Dowex 50 and KH_2PO_4 to diets in amounts calculated to react with most of dietary calcium, generally caused increases in the amounts of ingested ^{85}Sr secreted into milk; $MgSO_4$ similarly added caused a small decrease. The NaEDTA increased the value of $OR_{milk/diet}$ whereas the other substances did not affect it. Subcutaneous injection of parathormone caused slight decreases in the secretion of ingested ^{85}Sr into milk and the effect was reversed by cortisone. In goats, both treatments caused an increase in values of $OR_{milk/diet}$ but this effect was not observed in the cows. Calcium gluconate, NH_4Cl, NaEDTA and CaEDTA were administered by continuous intravenous infusion over periods of up to 200 hr. At the levels used, calcium gluconate caused about a 50 per cent reduction in the concentration of ingested ^{85}Sr in the milk; NH_4Cl had no effect; the salts of EDTA caused an increase. (auth)

17993 TRACE ELEMENTS IN DIETS AND EXCRETA. Tipton, Isabel H.; Stewart, Peggy Lou; Martin, Polly G. (Univ. of Tennessee, Knoxville). Contract W-7405-eng-26; Subcontract 2351. Health Phys., 12: 1683-9(Dec. 1966).

Analyses for trace elements were made on diets and excreta of two subjects on ad libitum diets for 30 days. The intake of each element was essentially the same for the two individuals. For the essential elements calcium, iron, magnesium and phosphorus the subjects were in balance and the patterns of excretion were the same. For minor trace elements, essential and nonessential, the excretory patterns differed widely. Estimates of f_1 for strontium based on fecal and urinary excretion gave values of 0.50 and 0.39; estimates based on urinary excretion gave values of 0.26 and 0.51. (auth)

17994 THE CHEMISTRY OF PSEUDOURIDINE. VII. SELECTIVE CLEAVAGE OF POLYNUCLEOTIDES CONTAINING PSEUDOURIDYLIC ACID RESIDUES BY A UNIQUE PHOTOCHEMICAL REACTION. Tomasz, Maria; Chambers, Robert Warner (New York Univ., N. Y.). Biochemistry, 5: 773-82(Feb. 1966).

Pseudouridine-3',5'-diphosphate (ψ3',5'DP) and pseudouridine-3'-monophosphate (ψ3'P) are converted by uv irradiation to 5-formyluracil inorganic phosphate, and an unknown fragment, whereas ψ2'P, pseudouridine 2',3'-cyclic phosphate, or pseudouridine itself produce only traces of 5-formyluracil under identical conditions. Specific cleavage of the oligonucleotide thymidylylpseudouridylylcytidylylguanylic 3'-acid (TpψpCpGp) and its pseudouridylic acid residue was achieved by irradiation with uv light: TpψpCpGp → TpY + 5-formyluracil + pCpGp, where Y is an unknown fragment derived from the pseudouridylic acid moiety. Examination of the stoichiometry of the reaction indicated that other, nonspecific, photochemical reactions were also occurring. These reactions caused a 15 to 20% loss in uv-absorbing material, but did not interfere with the detection of the predicted products. Irradiation of purified alanine-soluble RNA (s-RNA) followed by gel filtration on a Sephadex G-100 column at 56°C gave 4 partially resolved peaks. According to the nucleotide sequence of yeast alanine-s-RNA, 5 fragments (55, 39, 37, 21, and 15 nucleotides) could be produced by specific photolysis of the pseudouridylic acid residues. The positions of the peaks emerging from the Sephadex column were consistent with this prediction, and the peaks may represent polynucleotides containing 77 (starting material), 55, (39 + 37), and (21 + 15) nucleotides. (BBB)

17995 EFFECTS OF EXTERNAL IRRADIATION ON MINERAL METABOLISM IN THE BONES OF ADULT DOGS. Finston, R. A.; Woodward, H. Q.; Laughlin, J. S. (Sloan-Kettering Inst., New York). Clin. Orthopaed., No. 46, 183-201(1966).

Adult beagles were given intravenous injections of ^{85}Sr, and 15 to 86 days later one hind leg and one foreleg of each dog was given a dose of 870 to 2980 rad with 15-MeV electrons. At intervals of between 1 day and 448 days after irradiation the dogs were injected with ^{47}Ca. The retention of both isotopes was followed by external scanning. The ^{85}Sr which had been incorporated prior to irradiation was lost more slowly from the bones receiving 2000 rad or more than from their controls. The 96-hr retention of ^{47}Ca injected after irradiation was usually less in the irradiated bones than in controls. Recovery took place in a cyclic fashion with occasional overshoot 3 to 5 months after the lower doses, but with a subsequent depression for 7 to 14 months. These effects on uptake and loss of mineral label indicated an ultimate net decrease in bone mineral after the smaller and larger radiation doses, and increase in mineral after intermediate doses. These results in dogs were similar to those obtained in mice, and suggest that the same behavior may be found in the bones of other species, including man. The clinical observation that irradiated human bones may have radiographic densities either greater or less than normal is explained on the assumption that the relative injury to anabolism and catabolism is different in the two conditions. Since both effects are dose- and time-dependent, the variation of radiographic appearance with time is also explicable. Since depression of mineral uptake in dog bone persists for at least 15 months after even small radiation doses, the appearance of clinical evidence of radiation damage many years after exposure is to be expected also in humans. (BBB)

17996 THE EFFECT OF EXTRACTS FROM IRRADIATED BONE MARROW OF MICE ON THE CHROMOSOMES OF CHI-

NESE HAMSTER CELLS CULTURED IN VITRO. Barakina, N. F.; Yanushevskaya, M. I.; Urbakh, V. Yu.; Lubennikova, E. I.; Shapiro, I. M. (Severtsov Inst. of Animal Morphology, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 169: 1439-41 (Aug. 21, 1966). (In Russian).

A total of 5×10^4 Chinese hamsters cells/ml were introduced into a volume of 6 ml in 50 ml flasks. On the third day of culture growth, 0.5 ml of an extract from the bone marrow of irradiated and control mice was added to the culture. The irradiated mice were given a 1000 R dose of x rays two hours before the bone marrow extract was taken. The cultures were fixed in a mixture of alcohol and acetic acid 2, 4, and 6 hours after adding the bone marrow extract. Chromosomal aberrations were counted in cells at the stage of late anaphase–early telophase. After four hours treatment with the bone marrow extract, the cells treated with the unirradiated extract showed 30.6% chromosomal aberrations, of which 76.5% showed bridge damage only, and the cells treated with the irradiated bone marrow extract showed 41.0% chromosomal aberrations, of which 56.2% showed bridge damage only. With a six hour treatment, the corresponding figures were 22.5% for treatment with the unirradiated extract (63.2% showed bridge damage), and 41.1% for treatment with the irradiated cell extract (66.6% showed bridge damage). No change in mitotic index was observed. It was concluded that substances able to induce chromosomal damage appear in bone marrow cells of mice after irradiation. (TTT)

17997 EFFECT OF WHOLE-BODY IRRADIATION ON THE DEOXYRIBONUCLEOPROTEIN OF THE RAT THYMUS. Chang, Yung-lien; Chang, Yu-tuan (Inst. of Biochemistry, Shanghai). Sheng Wu Hua Hsueh Yu Sheng Wu Wu Li Hsueh Pao, 6: 231-8 (June 1966). (In Chinese).

Deoxyribonucleic acid (DNA) extracted from rat thymus tissues with phenol and sodium trichloroacetate (TCA-Na) increased in yields with increasing concentrations of the salt. The correlation between DNA yield and salt concentration was more or less characteristic of the tissue employed. After whole-body x radiation, more DNA was extracted from rat thymus homogenate with phenol and TCA-Na at all concentrations as compared with extraction yields from nonirradiated controls. The increase in yield of DNA extractable with 1.0% TCA-Na attained a maximum at 6 hours after irradiation with 300 R. The increase in yield was similar to the change in the percentage of pycnotic cells of thumus tissue. The dose-effect curve and response to protecting agents also showed a parallelism with those of cell population. The possible significance of the results was discussed in relation to the effect of changes in cell population on the observed chemical change. (auth)

17998 LABELED ANTIBODIES IN ELECTRON MICROSCOPY. Sternberger, Ludwig A.; Donati, Edward J. (Edgewood Arsenal, Md.). J. Histochem. Cytochem., 14: 606-7(Aug. 1966).

To confer extensive electron opacity on an antibody, so that it can be detected in an electron beam, it was necessary to immunospecifically protect the antibody-combining sites. The label was selectively reacted with the nonspecific areas of the antibody molecule and the specific antibody-antigen combining sites were left intact. A variety of extensive chelation and conjugation reactions can be conducted on the antibody molecule when so protected. In earlier work, antibodies chelated with up to 300 atoms of uranium per molecule were used. Recently, one of the new osmiophilic diazotized aminodiazo thioethers was coupled in large excess to antibody. The thioether-antibody became electron-opaque upon exposure to osmium tetroxide vapor. The protection phenomenon was so extensive that recovery of undamaged antibody remained unaltered even when alcoholic solutions were employed. More recently, the uranium-labeled antibody was intensified by bridging osmium through thiocarbohydrazide to the bound uranium. Even when antibodies possessing 300 atoms of uranium were used, it was necessary to avoid the ambiguity given by such fixatives as osmium tetroxide. The electron opacity of osmium completely masked the contrast afforded by unmodified uranium antibody. (BBB)

17999 CHEMICAL ANALYSIS AND BIOLOGICAL ACTIVITIES OF FATTY ACIDS FROM THE LIVER OF X-IRRADIATED RABBIT, THE ANTITUMOR AGENT SO-CALLED OX. Seno, Satimaru; Yamamoto, Michio (Okayama Univ., Japan). Acta Med. Okayama, 19: 59-72(Apr. 1965).

Chemical, biological, and morphological findings obtained in experiments with the unsaturated fatty acid fraction (OX) from the liver of rabbits are reported. The OX preparation used was obtained from the liver of rabbits that had received 3000 R whole-body x radiation in a single dose 24 hr prior to removal of the liver. Chemical analyses of OX revealed a refractive index n_D^{20} of 1.4715, an acid value of 25.4, a saponification value of 179.1, iodine number of 90 to 150, a peroxide value of 30.7, an unsaponifiable substance content of 17.5%, a conjugated dienoic acid content of 1.27%, a conjugated trienoic acid content of 0.033%, a negative ninhydrin reaction, a negative biuret reaction, a negative Molisch reaction, and a positive Liebermann–Burchard reaction. Gas chromatographic analyses revealed that the main constituents were oleic and linoleic acids with some stearic, palmitic, and palmitoleic acids. The percent content of components in unsaturated fatty acid fractions from x irradiated rabbit liver differed little from that of nonirradiated animals. An increased rate of autoxidation was observed in OX from x-irradiated rabbits. Similar characteristics were observed on unsaturated fatty acids fractions that were x-irradiated in vitro. Biologically, OX suppressed the growth of bacteria that required unsaturated fatty acids for growth; it was found to be slightly more active in the uncoupling effect on oxidative phosphorylation and on the swelling of mitochondria when compared to the effects of oleic and linoleic acids; and it showed a strong lytic activity on cell membranes as did linoleic, oleic, and some long-chain unsaturated fatty acids. Tumor cells surviving treatment with OX changed their characteristics temporarily and there was a slight retardation of cell development. (TSS)

18000 EXCITED STATES OF FLAVIN COENZYMES. II. ANEROBIC OXIDATION OF AMINO ACIDS BY EXCITED RIBOFLAVIN DERIVATIVES. Byrom, P.; Turnbull, J. H. (Royal Military Coll. of Science, Shrivenham, Eng.). Photochem. Photobiol., 6: 125-31(Feb. 1966).

Flavins were excited by uv light of 365 nm wavelength in the presence of amino acids. Anaerobic conditions were maintained in the buffered aqueous medium. Under these conditions photoreduction of the flavins occurred, with oxidation of the amino acids to keto acid and ammonia. The rates of oxidation of the amino acids were found to be strongly dependent on their structural nature. Certain known amino acid oxidase inhibitors quenched these photoreactions. Phenylalanine, in the presence of excited flavin mononucleotide (FMN) gave rise to the corresponding α-keto acid (phenylpyruvic acid) and ammonia. This behavior was typical of all the amino acids examined. At the same time the yellow color of the flavin faded as a result of reduction to the dihydroflavin. Rate curves for the selected amino acids showed the following order of reactivity: tyrosine < tryptophan < phenylalanine < serine ≪ cysteine < histidine ≪ methionine. Flavin photoreduction was also dependent on the nature of the amino acid present. However, in the case of FMN the situation is complicated by an intramolecular photoreduction of flavin, which takes place at an appreciable rate in the absence of amino acid. An inhibiting effect of chloropromazine, serotonin, dinitrophenol, and caffeine in the excited flavin-amino acid systems indicated that the oxidation of amino acids by photoexcited flavins and by the flavin oxidases most probably proceeds by a common mechanism. An activated triplet state of the flavin is proposed as an explanation of observed behavior. (BBB)

18001 ACTION OF X-RAYS ON THE HUMAN SERUM ALBUMIN MOLECULE. Suscillon, M.; Siffointe, R. (Centre d'Etudes Nucleaires, Grenoble). Pathol. Biol. (Paris), 14: 297-306(Mar. 1966). (In French).

Isotonic solutions of human serum albumin (20 g/l) were x-irradiated, and changes in various physical and chemical properties were examined. The effect of irradiated albumin on the erythrocyte sedimentation rate was measured by the Westergren method. Doses up to 24×10^5 R did not have any effect, but beyond this dose, the rate increased as the dose increased, up to a maximum of about 40×10^5 R, then decreased as the dose was raised further. The presence of free SH group in the irradiated albumin increased as the dose increased, up to a maximum at about 40×10^5 R, then began to decrease. Electrophoresis of the irradiated protein showed only one peak after doses up to 40×10^5 R, then a second peak appeared as the dose was increased. It was calculated that about 50% of the albumin becomes denatured at a dose of 16.4×10^5 R. The temperatures at which albumin is coagulated by heat progressively decrease as the radiation dose rises. These results indicate that between doses of 0 and 20×10^5 R few intramolecular disulfide bonds are broken. Between doses of 24 and 36×10^5 R, the tertiary structure of the protein is disrupted. At doses from 40 to 44×10^5 R, the sulfhydryl groups become oxidized as intermolecular disulfide bonds are formed. The protein molecules form aggregates which become insoluble and flocculate. (BBB)

18002 RESEARCH IN THE COMPLEXON SERIES. III. PRELIMINARY RESULTS OF THE STUDY, IN RATS, OF THE MODALITIES OF CALCIUM ELIMINATION AFTER ^{45}Ca-DTPA INJECTION. Truhaut, R.; Boudene, C.; Lutz, M. (Faculte de Pharmacie, Paris). Ann. Biol. Clin. (Paris), 24: 434-9(Mar.-Apr. 1966). (In French).

The exchange of radiocalcium from ^{45}Ca-DTPA administered

with stable body Ca was investigated. A single intravenous dose of 500-mg/kg ^{45}Ca-DTPA was given to rats, after which the urinary and fecal excretion and the bone uptake of ^{45}Ca were measured. On the 1st day postinjection, 21.4% of the ^{45}Ca injected was excreted in urine and 4.4% in feces. By the 6th day, a total of 37% of injected ^{45}Ca had been excreted by these 2 routes. Bone uptake accounted for 30 to 55% of the injected radioactivity. The exchange of ^{45}Ca bound to the injected DTPA with stable Ca in the body of the rats was higher than had been anticipated. (BBB)

18003 THEORY OF THE INACTIVATION OF DISULFIDE PROTEINS BY ULTRAVIOLET LIGHT. Dose, K. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 3: 259-63(1966). (In German).

Equations are proposed for the estimation of quantum yields for cystine destruction and disulfide protein inactivation during uv irradiation in slightly acidic solutions. Calculated values agreed with experimental values that are presently available. A quantitative discussion of intramolecular interactions is presented. (auth)

18004 ROLE OF THE KIDNEY IN PLASMA ALBUMIN CATABOLISM. RESULTS ON CLINICAL CASES WITH RENAL INSUFFICIENCY. Fujino, Akira (Tokushima Univ., Japan). Shikoku Igaku Zasshi, 22: No. 1, 150-67(Feb. 1966). (In Japanese).

The turnover of albumin in patients with renal disease, especially renal insufficiency, was studied using RISA (radioiodinated serum albumin). Iodine-131 was shown to be tightly bound to the protein moiety when circulating in the blood stream of patients. When the ^{131}I was liberated from the protein by albumin catabolism it was excreted in the urine. The function of excreting iodine by the kidney was not significantly disturbed in patients with renal insufficiency. The half life of RISA is 11.6 days in normal persons but is markedly shortened in nephrotic patients due to abnormal albuminuria and prolonged in patients with liver cirrhosis. Albumin turnover rate was decreased in patients with liver cirrhosis or renal insufficiency, and also in unilaterally nephrectomized patients. Iodine-131 excreted in the urine of normal persons was 50% of the original dose after 15 days; in nephrotic patients it was increased to 70 or 80%. Urinary excretion was decreased in patients with liver cirrhosis and renal insufficiency; it was slightly decreased in unilaterally nephrectomized patients. It was concluded that the kidney plays a significant role in catabolism of serum albumin and that the albumin turnover rate is significantly decreased when renal function is disturbed. (H.L.W.)

18005 TOXICOLOGY OF ^{222}Rn AND DETERMINATION OF THE RADIOACTIVE DEPOSIT IN THE ORGANISM. Furnica, Gh. (Inst. Igiena Protectia Muncii, Bucharest). Igiena (Bucharest), 14:649-58(1965). (In Rumanian).

It was possible to detect internal contamination with Ra, U, or Rn by determining the presence of ^{210}Po or ^{210}Pb in the urine of persons, especially immediately after the administration of EDTA. Internal contamination with ^{222}Rn brought about the formation of a radioactive deposit in organisms that was made up of ^{210}Pb and ^{210}Po radionuclides. The existing quantitative relationship between the urinary level of ^{222}Rn and ^{210}Pb or ^{210}Po permitted evaluation of the degree of internal contamination. The existence of a relationship between the amount of ^{210}Po and ^{210}Pb eliminated in the urine and the radionuclide charge in the body was assumed. (auth)

18006 EFFECT OF SODIUM LACTATE AND CORTISONE ON SOME INDEXES OF CARBOHYDRATE METABOLISM IN ACUTE RADIATION SICKNESS. Tkach, E. A. (Scientific-Research Inst. of Blood Transfusion, Lvov). Vop. Eksp. Klin. Radiol., Kharkov. Inst. Med. Radiol., No. 1, 60-4(1965). (In Russian).

Rabbits were irradiated with a single 800 to 50 R-dose of x rays, following which, beginning with the second and third day, they received intravenously, daily, for a 25 to 8 day period, 4 ml of an 8 to 10% $NaC_3H_5O_3$ solution per kg body weight. Some of these rabbits were simultaneously injected intramuscularly with 2.5 mg cortisone acetate for the same duration. Determinations of glycogen of the liver, skeletal muscles, and myocardium at the end of the experimental period revealed that in rabbits receiving $NaC_3H_5O_3$ the glycogen contents of the enumerated organs was 988, 173, and 145 mg %, respectively, and in animals administered $NaC_3H_5O_3$ and cortisone acetate 2649, 220, and 176 mg %, as against 2400, 300, and 160 mg % in normal rabbits. Determinations of $C_3H_6O_3$ in the blood of experimental animals revealed an 8 to 12 mg % rise in most of them. In another series of experiments, rabbits were exposed to the same dose of x radiation, were bled on the seventh and eighth day (25% of blood volume), and daily injections of $NaC_3H_5O_3$ and cortisone acetate, as well as transfusions, every 3 to 4 days, of 15 to 20 ml of normal rabbit blood were administered. Their liver, muscle and myocardial glycogen amounted to 2900, 153, and 146 mg %, respectively, while the blood $C_3H_6O_3$ varied greatly; blood sugar showed a persistent hyperglycemic trend. (auth)

18007 RESEARCH IN THE COMPLEXON SERIES. I. DETOXICANT CAPACITY OF Ca-DTPA IN EXPERIMENTAL CHRONIC PLUTONIUM POISONING IN RATS. Truhaut, R.; Boudene, C.; Lutz, M. (Faculte de Pharmacie, Paris). Ann. Biol. Clin. (Paris), 24: 419-26(Mar.-Apr. 1966). (In French).

The use of various chelating agents in the treatment of heavy metal poisoning is reviewed and experiments are reported on the effectiveness of diethylenetriaminepentaacetic acid (DTPA) in removing ^{239}Pu from rats. The 150-g, male Wistar rats were given 2 injections per week of 1 μC/kg Pu intraperitoneally for 4 weeks. At the end of this injection period 3-, 15-, or 30-mg/kg doses of Ca-DTPA were given intraperitoneally and repeated 7 days later. Daily urinary elimination of Pu was followed. In all DTPA-injected groups a sharp peak of increased Pu excretion was noted 1 to 2 days postinjection, the peaks being higher for the larger doses. (BBB)

18008 RESEARCH IN THE COMPLEXON SERIES. II. INFLUENCE OF THE REPEATED INTRAVENOUS ADMINISTRATION OF Ca-DTPA ON THE ELIMINATION OF TRACE ELEMENTS IN RATS. Truhaut, R.; Boudene, C.; Lutz, M. (Faculte de Pharmacie, Paris). Ann. Biol. Clin. (Paris), 24: 427-34(Mar.-Apr. 1966). (In French).

The urinary excretion of ^{239}Pu was shown to be markedly enhanced in rats by treatment with DTPA, but it is necessary to assess the effect of this chelating agent on the elimination of essential trace elements. Male Wistar rats were given 10 mg/kg intravenous doses of Ca-DTPA every 4 days, and urinary excretion of various elements was determined. The increase in renal elimination during DTPA treatment was low for Mn and Fe, moderate for Cu, but relatively high for Zn. Thus excretion of Cu was almost doubled and that of Zn increased 9-fold. When Ca-DTPA was given orally 5 times per week in doses of 300 mg/kg, no increase in Ca excretion was noted, and after an initial increase in Zn and Cu excretion, it was not marked after subsequent doses. It is recommended that, when DTPA is used in humans to treat Pu poisoning, supplements of Zn should be given. (BBB)

18009 THE PHYSIOLOGY OF GENE AND MUTATION EXPRESSION. Proceedings of a Symposium on the Mutational Process Held in Prague in August 9–11, 1965. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966. 339p. (CONF-650814–Vol.2).

The 45 papers included cover mechanisms of gene expression, mutation, and processes leading to recombination events. Separate abstracts were prepared for six papers. (M.M.B.)

For abstracts of individual papers see: 18010, 18011, 18031, 18032, 18193, and 18194.

18010 RIBONUCLEIC ACID SYNTHESIS AND THE ENHANCEMENT OF ULTRAVIOLET INDUCED MUTATION IN BACTERIA BY ACRIDINE DYES. Doudney, C. O. (Univ. of Texas, Houston). pp 29-38 of Physiology of Gene and Mutation Expression. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966.

The effects of acriflavine and acridine orange on mutation induction and survival in uv-irradiated Escherichia coli were studied utilizing the production of nontryptophan requiring prototrophs from cultures of the tryptophan requiring auxotrophic strain, WP2, as a measurement of mutation. The data indicate that in this strain of E. coli RNA synthesis must follow uv-irradiation if incubation in acriflavine and acridine orange is to enhance the mutagenic response and decrease the survival of exposed cells. The lower concentrations of dyes, which do not block RNA synthesis, are more mutagenic than higher concentrations at which RNA synthesis is blocked. The RNA formed at the maximally mutagenic concentration is soluble (possibly "messenger") and very little ribosomal RNA is formed under these conditions. An RNA-acriflavine complex is described which forms only after uv exposure and has sedimentation characteristics in the sucrose density gradient similar to those of the rapidly labeled or "messenger" RNA. It is suggested that this complex may play a role in the enhancement of uv effects by the dyes. (M.M.B.)

18011 REPAIR OF DAMAGE INDUCED BY A MONOFUNCTIONAL ALKYLATING AGENT IN BACILLUS SUBTILIS: RELATION TO THE REPAIR OF UV-INDUCED DAMAGE. Strauss, B.; Wahl-Synek, R.; Reiter, H.; Searashi, T. (Univ. of Chicago). pp 39-49 of Physiology of Gene and Mutation Expression. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966.

Biological inactivation of transforming DNA from Bacillus subtilis may occur following in vitro or in vivo exposure to either methyl methanesulfonate (MMS) or uv radiation. Using an indole$^+$

strain as donor, MMS-inactivated transforming DNA was demonstrated by sedimentation velocity analysis to contain single strand breaks, the number of which could be correlated with a decrease in the efficiency of transformation of indole-recipient cells by the preparation. DNA from treated cells could be repaired if the culture were incubated for 40 min following exposure. During this time period cells treated with either uv or MMS recovered from the damage without synthesis of new DNA molecules as demonstrated in experiments using labeled precursors. In order to compare the repair of DNA damage induced with MMS to that induced with uv, mutants were employed. Wild type B. subtilis, when acting as a recipient for transforming principle or as a host for phage SPO1, restores activity to both types of DNA. A mutant more sensitive to uv than wild type is able to repair MMS-induced DNA damage but not uv-induced. A mutant more sensitive to MMS than wild type does not restore either type of damage effectively. These results are considered consistent with the hypothesis that uv-induced DNA damage is repaired by at least 3 steps, while MMS-induced damage requires only the last stage of this repair sequence. (M.M.B.)

Ecology

Refer also to abstracts 18056 and 18184.

18012 (BNWL-360(Rev.)) PACIFIC NORTHWEST LABORATORY MONTHLY ACTIVITIES REPORT, NOVEMBER 1966, ON AEC DIVISION OF BIOLOGY AND MEDICINE PROGRAMS. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Dec. 1966. Contract AT(45-1)-1830. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Brief summaries are presented of work in progress in the following fields: radiation biology; the content of ^{137}Cs in forest floor samples of leaf litter; Columbia River ecology; fallout transport; geologic mapping of the Columbia River Basalt Plateau; whole-body counting of neutron-activated cadavers; the computer analysis of data from film dosimeters; and the development of radiation dosimeters for field use. (C.H.)

18013 (N-66-32122) ENZYME ACTIVITY IN TERRESTRIAL SOIL IN RELATION TO EXPLORATION OF THE MARTIAN SURFACE. Semiannual Progress Report No. 4, January 1-June 30, 1966. Skujins, J. J.; McLaren, A. D. (California Univ., Berkeley. Space Sciences Lab.). July 12, 1966. 81p. (NASA-CR-76549). CFSTI $3.00 cy, $0.65 mn.

Qualitative and quantitative tests were made for various enzyme activities in terrestrial soil for the purpose of adapting these procedures to investigations of Mars surface. Enzyme environments at interfaces and in Martian-like environments of limited water availability are being investigated. Analysis of phosphatase activity in native soils, and soils sterilized by irradiation revealed that no correlation was found between the seasonal variation in microbial numbers and phosphatase activity; however, both number and activity increased in samples of sterile, irradiated soil innoculated with native soil. Studies were initiated to elucidate the biochemical pathway of n-dodecane utilization by soil organisms. Instrumentation for the semiconductor solid state. C-14 carbon dioxide detector was developed for possible use with urea as a substrate for the detection of its catalytic (enzymatic) breakdown in a Martian environment. (auth)

18014 (AEC-tr-6206) ACCLIMATIZATION OF ANIMALS IN THE U.S.S.R. Proceedings of the Conference Held in Frunze, May 10-15, 1963. Yanushevich, A. I. (ed.). Translation of Akklimatizatsiya Zhivotnykh v SSSR, Materially Konferentsii po Akklimatiztsii Zhivolnykh, SSSR, Frunze, May 10-15, 1963. 264p. (IPST-Cat.-1218; CONF-630508-). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The fauna of the Soviet Union has been enriched by the acclimatization of hundreds of thousands of animals belonging to 32 different species of mammals, 10 species of birds, more than 50 species of fish, 15 species of insects, and others. Many of the acclimatized animals produce valuable fur and the catches of acclimatized fish are of significant economic importance. The introduction of useful insects has proved effective in the control of agricultural pests. The scientific basis of the acclimatization of animals is discussed. The acclimatization of mammals, birds, insects, fishes, and aquatic invertebrates in various regions of the USSR is discussed in 180 separate papers. (C.H.)

18015 (CEA-tr-R-1500) CONCENTRATION DES ISOTOPES RADIOACTIFS DU PHOSPHORE ET DU STRONTIUM PAR DIFFERENTES ESPECES DE MOLLUSQUES D'EAU DOUCE. (Concentration of the Radioactive Isotopes of Phosphorus and Strontium in Different Kinds of Fresh Water Mollusks). Poveljagina, Z. S.; Telitchenko, M. M. Translated into French from Byull. Moskov. Obshch. Ispyt. Prir., Otd. Biol., 64: No. 2, 79-83(1959). 15p. (In French). Dep. mn. JCL $1.60 fs, $0.80 mf.

The degree of accumulation by mollusks of the radioisotopes of P and Sr is a function of the concentration of the isotopes in the solution of the organotropism of the isotopes, and of the specificity of the species of mollusks. During the transfer of bivalve mollusks from a radioactive solution of strontium chloride to decantation water, a redistribution of the Sr isotopes is produced in the body and shell of the mollusk. The Sr isotopes are eliminated by the body of the mollusk, but they continue to be accumulated in the shell principally in its growing part. Bivalve mollusks can be used as one of the biocenosis elements of a decantation basin. (tr-auth).

18016 TOXIC SUBSTANCES AND ECOLOGICAL CYCLES. Woodwell, George M. Sci. Amer., 216: No. 3, 24-31(Mar. 1967).

Concentration and distribution of radioisotopes in the environment by biological and meteorological cycles are considered in a discussion of transport of toxic substances in ecological cycles and the consequent concentration of hazardous substances in biological materials. Three types of pathways for toxic substances are illustrated by the passage of ^{90}Sr, ^{137}Cs, and ^{131}I into the food chain. Movement and distribution of pesticides in the environment are exemplified by the cycling of DDT, which even in low concentrations is particularly hazardous to higher carnivores. (H.G.D.)

18017 FIELD STUDIES OF UPTAKE OF FISSION PRODUCTS BY MARINE ORGANISMS. Berner, Leo Jr.; Bieri, Robert; Goldberg, Edward D.; Martin, DeCourcey; Wisner, Robert L. Limnol. Oceanogr., 7: Suppl., 82-91(1962).

Field studies were conducted on the distribution of fission products between the marine waters and members of biosphere. Extensive data, compiled in 15 tables, are presented to show β and γ activity in numerous marine specimens (and in various organs of large fish) obtained in May, 1965, following detonation of a thermonuclear device. No chemical separations of fission product radionuclides were attempted. Some conclusions are drawn as to the interaction of the marine biosphere and marine hydrosphere in which the atomic detonation has occurred. The most effective concentrators of the activity in the oceanic realm were the mucous, ciliary, and pseudopodial filtering members of the zooplankton. From the limited assays on the diatoms, little could be concluded about the effect of phytoplankton as accumulators of activity. The only significant concentrations of activity in the fish were found in the stomach and gut regions. No long-term studies for sites of accumulation of specific isotopes were made. (BBB)

18018 ^{55}Fe LEVELS IN FISH AND IN FISH-EATING POPULATIONS. Nutr. Rev., 25: 24-6(Jan. 1967).

Although salmon and tuna were found to contain measurable quantities of ^{55}Fe, Eskimos consuming large quantities of these fish had less than 2.5% of the maximum permissible body burden of this radionuclide. Measurements of the concentration of ^{55}Fe in salmon, tuna, ocean perch, cod, whitefish, shee, sea bass, swordfish, herring, sardines, smelt, and saury revealed that saury caught in the plume of the Columbia River outlet along the Oregon coast contained the highest level. The average content was 106.0 nCi/kg. and was attributed to the high ^{55}Fe content in the cooling water of the Hanford nuclear reactor that empties into the Columbia River. Iron-55 content of salmon from the ocean off the Alaskan coast, from the Yukon River in Alaska, from Cook Inlet in Alaska, and from the Washington coast was relatively high. The differences in ^{55}Fe concentration in tuna fish from different areas of the oceans paralleled differences in concentration of ^{137}Cs, ^{60}Co, and ^{110}Ag in the same marine environments; however, ^{55}Fe concentrations were about 1000 times higher than concentrations of the other isotopes. This may be due to the fact that the concentration of stable iron in seawater was very low (about 10 $\mu g/l$). In salmon caught in the ocean off Alaska, the liver contained almost wet weight 2 μCi ^{55}Fe per kg wet weight. To determine the origin of the relatively high ^{55}Fe content in salmon, a variety of organisms in the marine food chain, dinoflagellates, euphausiids, mussels, kelp, barnacles, squid, purple sea cucumbers, and sea urchins was analysed. Iron-55 content in barnacles and purple sea cucumbers was highest. When ^{55}Fe content in blood samples from Alaskan Eskimos was studied, it was found that adult male Eskimos from Tanana, Alaska, who eat large quantities of salmon, had a much higher level of ^{55}Fe in their blood than Eskimos from the Anaktuvuk Pass who eat caribou. Some Alaskan natives were found to have body burdens of 2.3 μCi of this radionuclide: about 100 times greater than the average level observed in residents of the state of Washington. (BBB)

18019 ACCUMULATION OF MIXED FISSION PRODUCTS BY MARINE ORGANISMS: FORMAL DISCUSSIONS. Ophel, I. L. (Atomic Energy of Canada Ltd., Chalk River, Ont.). pp 275-84 of Proc. Second Intern. Water Pollution Res. Conf., Tokyo, 1964. New York, Pergamon Press, 1965.

Methods used for studies of ecosystems contaminated by radioactive wastes are described, and problems encountered in using a mixture of fission products, rather than a single radionuclide, and then following the accumulation of radioactivity in the experimental organism, are discussed. The use of mixtures introduces difficulties in the interpretation and application of the results. A table shows the changes that take place with time in a mixture of fission products derived from U after 50 days in a reactor. The changes in elemental composition of the mixture over a period of 500 days are striking. Even if accumulation experiments are confined to a single radionuclide there is great difficulty in translating the experimental results into useful information. Experiments on the effects of environmental factors on accumulation of ^{90}Sr by fish are described to demonstrate the difficulties in applying experimental concentration factors to natural ecosystems. It is suggested that only after the sp act. of the stable element in the water has been maintained at a constant value for a long period of time, years in the case of Sr, will a true equilibrium in an ecosystem be reached. At this time, the sp act. of the element in all of the ecosystem parts will be the same as that in the water only if the half-life of the tracer is long in comparison with the time taken to reach equilibrium. Any real advances in the prediction of the consequences of radioactive waste disposal into surface waters will require detailed studies of stable element metabolism by aquatic organisms and the geochemical cycling of these elements. (BBB)

Genetics and Cytogenetics

Refer also to abstract 18142.

18020 CHARACTERIZATION OF THE MITOTIC TRACTION SYSTEM, AND EVIDENCE THAT BIREFRINGENT SPINDLE FIBERS NEITHER PRODUCE NOR TRANSMIT FORCE FOR CHROMOSOME MOVEMENT. Forer, Arthur (Dartmouth Medical School, Hanover, N. H.). Chromosoma, 19: 44-98 (1966).

Living crane fly (Nephrotoma suturalis) spermatocytes were irradiated with a uv microbeam in various areas, and uv-induced changes in chromosome movement and in spindle fiber birefringence were measured. The traction system was localized in the chromosomal spindle fibers; and undamaged traction fiber extending at least ½ the fiber length (from the chromosome) is necessary for normal movement. The birefringent fiber is separate from the traction fiber, and therefore the chromosomal spindle fiber is composed of at least 2 components. Otherwise, the following results characterize the traction fiber: birefringence is not necessary for movement, birefringence and movement are affected independently, the birefringent fiber moves poleward when the associated chromosome does not move, and the birefringent fiber moves poleward at a rate not related to that of the associated chromosome. These results are explained under the assumptions that during anaphase the birefringent fiber is independent of the traction fiber, and that prior to anaphase the birefringent fiber is not independent of the traction fiber. The interdependent movement of sister dyads is mediated via functioning kinetochores. This interdependence is mediated via kinetochore-interzonal region interactions, and the interzonal region is involved with regulating the amount of force on the chromosome. (BBB)

18021 RADIOMUTABILITY AND HETEROGENEITY OF MALE GERM CELLS OF DROSOPHILA BEFORE, DURING, AND AFTER MEIOSIS. Fritz-Niggli, Hedi (Univ., Zurich). Biophysik, 3: 97-117(1966). (In German).

A cytological study of the testes of Drosophila melanogaster in the larval and prepupal stages was made, following electron and gamma irradiation. Irradiation of larval and prepupal stages resulted in heterogeneity of developing germ cells. Heterogeneity was evident in radiosensitivity and in mutability of germ cells. The effect of radiation on the frequency of dominant lethal factors was studied. Mortality of embryos was highest after irradiation of spermatocytes in 78 to 91 hour larvae. Recessive sex-linked lethal factors were observed frequently in meiotic and post-meiotic stages of germ cells. Translocations occurred rarely in spermatocytes and spermatogonia. Chromosome losses occurred in meiotic and post-meiotic stages more often than in spermatocytes. (H.L.W.)

18022 EFFECTS OF COSMIC RADIATION AND OTHER SPACE FLIGHT FACTORS ON LYSOGENIC BACTERIA AND HUMAN CELLS IN CULTURE. Zhukov-Verezhnikov, N. N.; Maiskii, I. N.; Pekhov, A. P.; Rybakov, N. I.; Dobrov, N. N.; Antipov, V. V.; Kozlov, V. A.; Saksonov, P. P.; Podoplelov, I. I. Izv. Akad. Nauk SSSR, Ser. Biol., No. 4, 592-3(July-Aug. 1966). (In Russian).

Space flight factors exerted a definite effect on the hereditary reactions of lysogenic bacteria. An inconsiderable but statistically significant increase in induced phage production was observed. The inducing effect was more pronounced in lysogenic bacteria that were exposed to space flight factors aboard the Vostok-3 spacecraft. Vostok spacecraft flights took place in orbits where no factors that were capable of producing genetic anomalies that could cause the development of malignant tumors or hereditary diseases were present. (auth)

18023 THE EFFECTS OF X-RAYS ON THE CHROMOSOMES OF LOCUST EMBRYOS. II. CHROMATID INTERCHANGES AND THE ORGANIZATION OF THE INTERPHASE NUCLEUS. Fox, D. P. (Univ. of Aberdeen, Scotland). Chromosoma, 20: 173-94(1966).

The structure and frequency of chromatid interchange types induced by x irradiation of Schistocerca gregaria embryo cells in the late S or early G_2 stage are described. These interchange types occur with different frequencies. On the basis of the observed polarization of the chromosomes in interphase and of the observed occurrence of loops in these polarized chromosomes in embryo cells, a model is described which can account for these differences. The model has 6 main features. The chromosomes in the interphase nucleus are polarized and lie parallel, possibly close to the nuclear membrane. U-type exchanges are fundamentally different from X-type exchanges and U-type exchanges are more frequent than X-type. Twisting at the point of exchange, between formation in interphase and observation at C-metaphase, is rare. The chromosomes have looped regions which may take part in interchanges. Chromosome ends may be involved in interchanges due to terminal overlapping in the nucleus as the chromosome elongates during interphase. The latter two factors result in aberrations between polarized chromosomes in interphase appearing in a non-polarized position at C-metaphase. Evidence supporting this model was derived from a study of the exchange point relative to the 2 centromeres and 2 telomeres, since the mean centromere distance C, mean telomere distance, T, and mean differential distance D are expected to be different for the various hypothetical modes of aberration formation. The model implies that if the mechanism of chromosomal aberration formation is by breakage and reunion, rejoining within a site cannot be at random. Thus the results are more compatible with an exchange type of mechanism for aberration formation. (BBB)

18024 FREQUENCY AND TYPE OF CHROMOSOMAL DAMAGES INDUCED BY UV RADIATION IN CULTURED CHINESE HAMSTER CELLS. Tolkatcheva, E. N.; Shakhova, I. K.; Mantsygin, Yu. A.; Shapiro, N. I. (Kurchatov Inst. of Atomic Energy, Moscow). Genetika, No. 1, 65-73(Jan. 1967). (In Russian).

The mechanism of formation of chromosomal aberrations was studied with the use of uv irradiation (λ = 2537 Å, 90 erg/mm^2) in a line of quasidiploid Chinese hamster cells. It was shown that for cells cultured in vitro each phase of the cell cycle has its own spectre of uv-induced chromosomal aberrations. Thus, at the phases G_1 and the early and middle S, numerous exchanges and cells containing multiple aberrations were observed. Gaps were noted at the G_2-phase. The estimate of the relative radiosensitivity at different phases of the mitotic cycle depends on the criterion adopted for the quantitative evaluation of nuclear damages. If the number of chromosome breaks per cell be used as such a criterion, the radiosensitivity of different phases of cell cycle increases as follows: $G_2 < S_{late} < S_{early} < G_1 < S_{middle}$. A mainly random distribution of breaks along the first chromosome was observed at all phases. It should be pointed out, however, that some regions of chromosome I were damaged more frequently than the others (region N11 at the phase G_1, region N7 at the phase S_{early}). (auth)

18025 EFFECT OF X-RADIATION ON THE GROWTH AND DIVISION PROCESS OF TETRAHYMENA PYRIFORMIS. Schmid, Peter (Naval Radiological Defense Lab., San Francisco). Biochem. Biophys. Res. Commun., 26: 615-20(Mar. 9, 1967).

In experiments reported here cell replication in Tetrahymena pyriformis was blocked by sublethal doses of x-irradiation shortly after the beginning of irradiation. However, small (initially young) cells grew at the same exponential rate as large (old) cells and the volume distribution remained lognormal indicating that cell growth is significantly independent of the division cycle. In contrast, DNA synthesis ceased at the beginning and was resumed during irradiation with exponential kinetics indicating an adaptation of unknown character. (auth)

18026 SIMULTANEOUS MEASURE OF X-RAY INDUCED X-Y AND AUTOSOMAL CROSSINGOVER IN SPERMATOCYTES OF DROSOPHILA. Zimmering, S.; Johnsen, R. C. (Brown Univ., Providence, R. I.). Z. Vererbungsl., 98: 137-40(1966).

X rays induce crossingover between X and Y chromosomes in primary spermatocytes of Drosophila. A study of the relation be-

tween the pattern of induced X-Y and autosomal crossingover suggested that the 2 patterns are different. Radiation-induced X-Y and autosomal crossingover was followed in primary spermatocytes of Drosophila males. Males of the composition $y/B^{s}y^{+}$ were irradiated 1 to 2 hr after the prepupal stage and mated daily with 3y; dp cn bw females. The results indicated that the frequency of recovered X-Y crossovers is highest in the late spermatocyte stage about to undergo the first meiotic division, whereas the peak frequency of autosomal crossovers occurs in earlier spermatocytes. The results are explainable if (1) a more appropriate pairing configuration exists between X and Y than between autosomes at later stages of the primary spermatocyte, a situation which is reversed in earlier stages; (2) breakability of Y (and/or X) heterochromatin and centromeric heterochromatin of autosomes are different from each other at different stages of the primary spermatocyte; or (3) a combination of both. (BBB)

18027 LOCI FOR RADIATION SENSITIVITY IN ESCHERICHIA COLI STRAIN B_{s-1}. Greenberg, Joseph (Palo Alto Medical Research Foundation, Calif.). Genetics, 55: 193-201(Feb. 1967).

Escherichia coli B_{s-1} is more sensitive to uv radiation than the parent strain B. It is also less efficient than B in reactivating certain uv irradiated coliphages (HCR^{-}). It cannot excise uv-induced thymine dimers from its DNA, therefore, lacking the dark reactivating mechanism of its parent. B_{s-1} was shown to contain two mutant genes, each of which alone can result in radiation sensitivity, but only one of which is responsible for the HCR-property One is linked to mal B and a second is in the region between the points of entry of HfrC and HfrHB33. Mutation to uv sensitivity in the second region is accompanied by a loss of HCR properties. Strain B_{s-1} is more sensitive to uv than are strains carrying either mutation alone. (TSS)

18028 RADIATION INDUCED TANDEM DUPLICATIONS IN DROSOPHILA MELANOGASTER. Bender, Harvey A. (Univ. of Notre Dame, Ind.). Genetics, 55: 249-54(Feb. 1967). (COO-38-507).

Tandem direct duplications of the lozenge (lz) region of the X chromosome of Drosophila have been induced by X-irradiation of the diploid meiotic stages of the female. Detection was based upon partial complementation between two of the lz pseudoallelic mutants, and the duplications were confirmed by cytological and genetic analysis. (auth)

18029 STERILITY, CHROMOSOME BREAKAGE, X-RAY-INDUCED MUTATION RATES AND DETECTED MUTATION FREQUENCIES IN DROSOPHILA MELANOGASTER. Lefevre, G. Jr. (San Fernando Valley State Coll., Northridge, Calif.). Genetics, 55: 263-76(Feb. 1967).

In experiments on Drosophila melanogaster where the frequency of sex-linked recessive lethal mutations was determined following irradiation with 4000 R of male germ cells at different stages of maturity, all F_1 females were inspected for the presence of visible changes at the y, w, v, and f loci, as well as for Notch and white-mottled mutations. Further, the occurrence of hyperploid males was noted. The fertility of both phenotypically normal and mutant F_1 females was compared, as was the frequency of mutants in the fertile and sterile classes of F_1 females. The results indicate that differential chromosome breakage or restitution of breaks, not differential gene mutability, is primarily responsible for the differences in lethal mutation frequency detected at successive intervals following irradiation. Further, chromosome mutants contribute to both inviability and sterility of F_1 females. Thus, variations in recessive lethal mutation frequencies do not necessarily reflect true differences in the mutability of different germ cell stages exposed to given doses of X rays. Insofar as mutants with cytologically normal chromosomes are concerned, induced mutation rates are little, if any, different in all postmeiotic male germ cell rates. (auth)

18030 AN ANALYSIS OF RADIATION-INDUCED VARIATION ON BODY-WEIGHT OF HABROBRACON JUGLANDIS. Dalebroux, Marc A.; Kojima, Ken-ichi (North Carolina State Univ., Raleigh). Genetics, 55: 315-28(Feb. 1967).

A quantification of the genetic variability induced by gamma-irradiation was carried out with quantitative characters of Habrobracon juglandis. Adult female (diploid) and male (haploid) body weights were studied in homozygous and heterozygous genetic backgrounds. The dose-response relation was determined with respect to body weights of females that might be heterozygous for induced mutations. The responses to 0, 1.0, 1.5, 2.5 and 4.0 kR irradiations were measured using the F-ratio between the variances among family means in the irradiated material and in the control. The maximum response was obtained at 1.5 kR. Induced genetic variability was studied in detail with 1.5 kR irradiation. (1) A striking increase of genetic variance was observed for induced-mutation-heterozygote females in either homozygous or heterozygous genetic background. (2) A great increase of genetic variance was also observed among males segregating for induced mutations in an otherwise homozygous line (i.e., males produced by mutation-heterozygote females with the homozygous genetic background). However, there was no significant increase of genetic variance among males produced by mutation-heterozygote females with the heterozygous genetic background. These findings suggest that (a) induced mutations can increase or decrease body weight, (b) induced mutations affecting body weight are not necessarily recessive to their wild-type alleles, and (c) there are little or no nonallelic interactions between induced mutations and the rest of the genes affecting body weight. (auth)

18031 THE EFFECT OF UV AND HNO_2 ON RECOMBINATION IN ASPERGILLUS. Kwiatkowski, Z. (Univ. of Warsaw). pp 253 of Physiology of Gene and Mutation Expression. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966.

Both uv irradiation and HNO_2 affect an increase in nonallelic mitotic recombination in Aspergillus. The effect of irradiation on allelic mitotic recombination depends on the combination of mutational sites in heterozygous diploids. (M.M.B.)

18032 EFFECT OF HOMOLOGOUS DEOXYRIBONUCLEIC ACID ON THE MUTATION FREQUENCY IN IRRADIATED ESCHERICHIA COLI POPULATION. Igali, Sandor (Frederic Joliot-Curie National Research Inst. for Radiobiology and Radiohygiene, Budapest). pp 89-93 of Physiology of Gene and Mutation Expression. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966.

Homologous highly polymerized DNA was shown to have a radioprotective effect by its ability to reduce radioinduced back-mutation in Escherichia coli 113-3, a methionine-less strain. When exposed to x radiation doses of 9, 18, and 36 kR/43 kV in the presence of 10 μg/ml homologous DNA, prototroph formation was reduced to about 30% of that in controls for all doses. Heterologous DNA doesn't have this effect. If homologous DNA is added to the cell suspension after irradiation there is a reduction in the number of prototrophs, but less than when it is present during irradiation. (M.M.B.)

18033 IVORY, AN EYE-COLOR MUTATION IN TRIBOLIUM CASTANEUM. Bartlett, Alan C.; Bell, A. E. (Dept. of Agriculture, State College, Miss.). Ann. Entomol. Soc. Amer., 59: 865-6(July 1966).

A population of Tribolium castaneum beetles was treated with x radiation and an ivory mutant, creamy-white eyes, was isolated. The eyes of the ivory mutant have a spectacled appearance that is reminiscent of pearl. Reciprocal crosses of ivory to wild-type yielded all wild-type offspring. Crosses among F_1 individuals and backcrosses of F_1 hybrids to ivory gave offspring characteristic of monohybrid Mendelian inheritance. In these matings, ivory exhibited complete penetrance and acted as an autosomal recessive gene. Viability of ivory homozygotes approaches that of the normal wild-type. Linkage relations with genes on the previously marked chromosomes were carried out. The backcross data for repulsion crosses are reported. Reciprocal crosses of ivory and pearl gave wild-type offspring. The close resemblance between the two mutant phenotypes handicapped recombination study, but F_2 data suggested that ivory and pearl are closely linked and at equal distance from pegleg. The occurrence of the ivory mutant emphasizes the need for study of possible homologies between mutants in other species, as well as the biochemical relations between similar mutants of the same species. Biochemical study of the two eye mutants, pearl and ivory, might yield significant information concerning the biosynthesis of eye pigments in both Tribolium and other insects. (BBB)

18034 CYTOLOGICAL AND CYTOGENETICAL STUDIES ON PARAMECIUM POLYCARYUM. VI. EFFECTS OF GAMMA IRRADIATION ESPECIALLY CONCERNING NUCLEAR DIVISION IN CONJUGATION. Hayashi, Shinji (Fuji Women's Coll., Japan); Takayanagi, Tan. Annot. Zool. Jap., 39: 16-22(Mar. 1966).

A number of conjugating pairs of Paramecium polycaryum received 132, 175, 196, and 245 kR of gamma irradiation from a cobalt-60 source at the following four stages: the 1st pregamic division, the 3rd pregamic division, syngamy, and the 1st postgamic division. Irradiation at the 1st pregamic division resulted in a striking inhibition of the micronuclear division in conjugants. Those irradiated at the 3rd pregamic division and the syngamy stages produced a few abnormal exconjugants which had only one or two macronuclear anlagen. Under exposure in the 1st postgamic division, the organisms underwent the 1st and 2nd postgamic divisions in a normal manner, but in the eight-nucleate stage when the 3rd postgamic division was completed, they showed abnormal numbers of nuclei, varying from 4 to 8, six being most frequent. This seems to be correlated with the fact that the

organisms containing two macronuclear and four micronuclear anlagen are frequent in occurrence. There is a possibility that the critical time in differentiation of the macro- and micronuclei may be in the stage after the 1st or 2nd postgamic division. (auth)

18035 BIBLIOGRAPHY ON AUTORADIOGRAPHIC STUDIES OF MAMMALIAN CHROMOSOMES. German, James (Cornell Univ., New York). Ann. Genet., 9: 137-40(Sept. 1966).

By the end of 1960, only 2 papers had appeared describing autoradiographic studies of mammalian (hamster) chromosomes. In 1961 the first autoradiographic studies of human chromosomes appeared in print with 4 reports that year. By the end of 1965, there were at least 155 reports, and the studies had been extended to many species. Various isotopically labeled compounds had been applied to both somatic and germ-line cells, in vivo and in vitro. A comprehensive bibliography is provided of the reports of autoradiographic studies of mammalian chromosomes published in the scientific literature through the end of 1965. (BBB)

18036 THE USE OF INTERCHANGES INVOLVING B-TYPE CHROMOSOMES IN STUDYING ARTIFICIAL MUTAGENESIS IN MAIZE. Bellini, G.; Bianchi, A.; Ottaviano, E. (Univ. of Milan). Z. Vererbungsl., 92: 85-99(1961).

Seeds of maize inbred lines A158, A158T, WF9, and WF9T (T = Texas factor for male sterility), with a water content that ranged from 12 to 7% were irradiated with 1 to 16 kR of x radiation. Plants grown from these seed were crossed with TB-A stocks that possessed chromosomal interchanges between A and B chromosomes. Because of nondisjunction of the B^A chromosomes in the microspore second mitosis, the production of hypoploid endosperm and embryo of F1 ears occurred in high percentage. The A chromatin segments involved in B^A chromosomes were estimated to possess from about 100 "genes" to more than 600, according to their size. About 4000 control and 1000 ears from treated material were examined. While the number of ears showing poor seed setting or lethal factors was correlated with R doses, chromosomal aberrations increased with the R doses. On the contrary, endosperm and seedling mutations were not significantly increased by any treatment. Results confirmed the chromosomal nature of the greatest majority of artificially induced mutations in maize that could be obtained under the experimental conditions employed. The detectable rate mutation, both spontaneous and x ray-induced, did not seem to be correlated to the size of the chromatin segments analyzed. (B.H.S.)

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Refer also to abstracts 17564, 17979, 18005, 18012, 18019, 18795, and 19295.

18037 (IS-1523) SURVEY OF ENVIRONMENTAL RADIOACTIVITY. Voss, Milo D. (Ames Lab., Iowa). Jan. 1967. Contract W-7405-eng-82. 46p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Environmental monitoring program of the Ames Laboratory of the USAEC for the Ames Laboratory Research Reactor (ALRR) are discussed. The environmental program consists of gross alpha and beta determinations of air, soil, vegetation, river water, ALRR outfall, bottom sediment, precipitation, well water, and pond samples. The ALRR reached full power as of 7/12/65. As of 12/31/65 the ALRR had generated 899.6310 megawatts of heat. A total of 11,027.1761 megawatts of heat was generated in 1966. The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. The conclusion is reached that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity. (auth)

18038 (NP-16544) ^{90}Sr IN HUMAN BONE, DENMARK, 1962-1964. Levi, H.; Lindemann, J.; Nielsen, A. (Copenhagen Univ. (Denmark)). 5p. Dep. mn.

Data are given on Sr-90 content in bones of fetuses 1 to 30 days old and children 1 month to 10 years old. The results show that Sr-90 content of bone of humans under 10 years of age has increased steadily during the period of June 1962 to June 1964. Between June 61 and June 62 S. U.-values of fetuses scattered about a mean of 0.4. Between June 62 and 63 S. U.-values had risen to between 1.0 and 1.5, and in the corresponding period 1963 to 1964, the S. U.-values approached an average of 3. It appears that the scatter of the S. U.-values of older children is much larger than that of fetuses or infants, as observed earlier. (auth)

18039 (ORNL-P-2597) HEALTH PHYSICS ASPECTS OF SUPERSONIC TRANSPORT. Snyder, Walter S. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 18p. (CONF-660920-12). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 1st International Congress of the International Radiation Protection Assn., Rome, Italy.

The ICRP Task Group report estimated, conservatively, that the average dose rate of galactic and solar radiation on a polar route and at 60,000 to 80,000 feet could be as much as 3 mRem/hr. For the great bulk of travelers who make only a few flights a year, this was considered to be well within the limits on exposure of individuals of the population to cosmic radiation as recommended by the ICRP and was not considered to pose a problem. For a courier or crew who continually makes such trips, it was considered to be another matter, and consideration was given to the fact that these people should be classed as radiation workers. It was explained how a schedule of 40 hr/mo in actual flight over high latitudes might entail an average radiation dose of 1.5 Rem/yr; this was considered to be a generally conservative estimate. It was noted that some of the present plans provide for monitoring instruments to be placed aboard aircraft and that these should provide better estimates as to actual radiation doses received. It was also noted by the ICRP Task Group that when time factors and the fraction of the population likely to be involved were taken into account, the contribution to the total genetic load was small. (B.H.S.)

18040 (USNRDL-TR-67-7) A FORTRAN PROGRAM TO DETERMINE ABSORBED ORGAN DOSE DUE TO INHALATION OF RADIONUCLIDES. Wong, P. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 11, 1967. 115p.

A FORTRAN computer program system was developed to determine the maximum internal dose received by a given body organ as a result of inhalation of specific radionuclides. The program, based upon equations reported in the literature, determines the effective energy absorbed by the body organ per disintegration of the radionuclide and computes the absorbed organ dose for various periods of intake for single or continuous release and for various periods of internal exposure. The organ dose includes effects from all descendants of the nuclide originally considered to have entered the body organ. Tabulated results for 133 radionuclides and their contributions to the dose to seven body organs and the whole body are presented. Input to the FORTRAN computer program may be modified to yield results for other radionuclides or body organs. The computer program may also be used to determine (by summing) the total absorbed organ dose for a mixture of fission products if the concentration in air of each major contributor at initial intake time is known. (auth)

18041 (USNRDL-TR-1107) MODELS FOR ESTIMATING BETA DOSE TO TISSUE FROM PARTICLE DEBRIS IN AEROSPACE NUCLEAR APPLICATIONS. Ulberg, J. C.; Kochendorfer, D. B. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 12, 1966. Contract AT(49-5)-505. 83p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three beta-dose models developed to calculate beta dose in tissue from radioactive fragments created by the destruct and consequent re-entry of a nuclear-powered aerospace vehicle into the earth's atmosphere are described. The models were developed in response to a requirement by the Space Nuclear Propulsion Office for a beta-dose model that would give reasonably approximate beta-dose results in tissue in the shortest possible time, so that this model could be included in a complex nuclear-flight safety program. The most sophisticated of the three models combined Monte Carlo beta-transport techniques with beta-spectrum degradation and electron-energy-dissipation methods. As this model requires excessive amounts of computer time, a second model employing exponential absorption was developed. This model gives satisfactory agreement with the more theoretical model when a suitable value for the constant in a particle mass-absorption-coefficient equation is applied. As experimental values of dose from high-Z, high mass-density particles generally range from two to four times lower than the theoretically calculated value, the addition of a third, empirical model seemed justified. This model contains an apparent electron absorption factor that is based on the limited amount of experimental beta-dose data available. A comparison of the dose rates in tissue from the three models for typical reactor running conditions, along with expected beta doses from particles created by a hypothetical nuclear-engine destruct are included. (auth)

18042 (USNRDL-TRC-42) DECONTAMINATION SCHEDULING PROCEDURES FOR RADEF SYSTEMS. Lee, Hong (Stanford Research Inst., Menlo Park, Calif.). Aug. 1966. Contract N228-(62479)65421. 82p. CFSTI $3.00 cy, $0.65 mn.

This report presents a decontamination scheduling procedure that permits the user to correlate target analysis results, shelter protection factors, and decontamination data and systematically obtain feasible decontamination assignments and decontamination schedules. Because the procedure delineates individual exposure

doses for all contemplated exposure periods, clear choices of personnel assignments and scheduling options are presented. Scheduling examples are given to demonstrate the procedure, and procedural aids are included to minimize decontamination scheduling calculations. This report also demonstrates how the decontamination scheduling procedure may be used to evaluate the effectiveness of RADEF systems. The examples for decontamination scheduling and for RADEF system evaluation indicate that target area decontamination is a task requiring a relatively large decontamination organization. (auth)

18043 QUANTITY OF RADIATION REACHING THE OVARY DURING GYNECOLOGICAL X-RAY INTERVENTIONS, WITH RESPECT TO THE RAY QUALITY AND THE POSITION OF THE OVARY. Nikl, Istvan (Frederic Joliot-Curie National Research Inst., Budapest). Magyar Radiol., 18: 307-12(Oct. 1966). (In Hungarian).

In order to measure the ovarian ray doses during the x-ray examinations of the ovary, a phantom was constructed. With regard to ray quality and the position of the ovary, the results of the measurements are presented in tabular form. Data on the ray energy absorbed by an ovary weighing 7 g (in gram rad value) during these x-ray examinations are presented. (auth)

18044 A COMPUTER PROGRAM FOR β-EMITTERS EMPLOYING LIQUID SCINTILLATION COUNTING SYSTEMS. Creger, C. R.; Ansari, M. N. A.; Couch, J. R.; Colvin, L. B. (Texas A and M Univ., College Station). Atompraxis, 13: 24-7(Jan. 1967).

A program has been written for the IBM 7094 computer which will calculate the absolute activity of β-emitters when used as tracers in biological studies involving liquid scintillation spectrometry. The isotope used as an example for data calculation was ^{89}Sr. The program provides for rapid calculation of large amounts of data in extremely short periods of time. Decay, background counts, quenching and dilution factors are all taken into account by the program. Precision and counting statistics are also provided for in output data. In addition, the specific activity of any sample may be determined and any or all data can be retrieved in any desired sequence. (auth)

18045 ECOLOGICAL DOSIMETRY: RADIATION LEVELS INFLUENCED BY PLANT GROWTH. Ashby, William C.; Beggs, James N.; Kastner, Jacob; Oltman, B. G.; Moses, Harry (Argonne National Lab., Ill.). Science, 155: 1430-2(Mar. 17, 1967).

The feasibility of using lithium-7-fluoride thermoluminescent dosimeters under field conditions for natural radiation at levels of 5 mR is demonstrated. Radiation dosages in tree trunks increased three-fold from winter to spring and summer. The increase was attributed to the γ radiation field resulting from relatively high levels of ^{40}K and other radionuclides present in the foliage and branches during the growing season. (auth)

18046 FALLOUT OF THE COLD WAR. New Engl. J. Med., 274: 1442-3(June 23, 1966).

Hazards of radioisotopes, particularly ^{131}I to the thyroid, are briefly considered, with reference to thyroid disorders detected recently in Marshall Islanders exposed accidentally to fallout from a nuclear detonation years earlier. The experience reported in the Marshall Islanders is unusual in that the prime response was multinodular goiter formation, rather than induction of tumors. (TSS)

18047 CIVIL DEFENCE FOR BRISBANE. Liddle, William. Med. J. Austr., 1: 991-2(June 4, 1966).

The probability that persons injured by a hypothetical thermonuclear explosion over Brisbane, Australia would receive adequate medical treatment was analyzed. It is supposed that a weapon chosen for Brisbane, with a population of 600,000, would kill 200,000, injure 200,000, and leave 200,000 unscathed. The problem, therefore is resolved into treatment of 200,000 injured people by 200,000 survivors, pending the arrival of organized aid from a distance. (TSS)

18048 CONSIDERATIONS OF BIOSPHERIC CONTAMINATION BY RADIOACTIVE FALLOUT. Langham, Wright H. (Los Alamos Scientific Lab., N. Mex.). pp 2-18 of Radioactive Fallout, Soils, Plants, Foods, Man. Fowler, Eric B. (ed.). Amsterdam, Elsevier, 1965.

The world inventory of ^{90}Sr and ^{137}Cs contamination, distribution of the two nuclides, mode of their incorporation in man from his environment, and radiation exposure from fallout and its potential biological significance are reviewed. Estimates of the maximum 30-yr gonadal dose and 70-yr bone and bone marrow doses for the U. S. population resulting from ^{137}Cs plus ^{90}Sr fallout are tabulated and compared with the doses expected from natural background radiation. The predicted dose rate and the integrated 30-yr gonadal dose from present levels of biospheric contamination are between 1 and 2% of that from natural background, and it is concluded that the potential genetic hazard to the world population from weapon tests to 1962 will not be more than 1 to 2% of the unavoidable burden from natural sources of radiation. Estimation of the potential somatic consequences of biospheric contamination from weapon testing is discussed. (TSS)

18049 PUBLIC HEALTH EVALUATION OF NUCLEAR POWER PLANTS. Weaver, Charles L. (Dept. of Health, Education, and Welfare, Washington, D. C.); Stigall, Garry E. Health Phys., 13: 189-96(Feb. 1967).

The potential effect on the public health and the environment from the proposed operation of major nuclear reactor facilities is being evaluated. In the past year several reactors in the 1200–1600 MW thermal power have been evaluated prior to commencing construction. The role of the Public Health Service in providing assistance to State health agencies on potential environmental problems is discussed. Evaluation of stationary reactor installations is specifically directed to meet the needs of State and local public health and other agencies which have responsibilities related to the proposed construction and subsequent operation of nuclear power plants. (auth)

18050 ON THE DETERMINATION OF THE POPULATION BURDEN FROM NATURAL EXTERNAL RADIATION ON THE TERRITORIUM OF THE G.D.R. Ohlsen, H.; Herrmann, D. (Staatliche Zentrale fuer Strahlenschutz, DDR, Berlin). Kernenergie, 9: 390-6(Dec. 1966). (In German).

Dose rates measured by a 23 l. ionization chamber in the territory of the G.D.R. are reported. Moreover, dose rates are determined from results of radiogeological (partially airborne and carborn) measurements. The terrestrial component of the dose rate in open air is studied under characteristic conditions in the environs of the points of measurements (forest, field, road, etc.) and in the geological underground structure (granite, cretaceous formation etc.). A mean terrestrial dose rate of 90 mR/year follows from a method of averaging the results with regard to the various fractions of the populations as weighting factors. The attempt of estimating the mean gonad dose from external radiation of terrestrial and cosmic sources gives an amount of 109 mrem/year for the whole population. This result is satisfactory in accordance with international values for normal regions. However, it is given with reservation as to further dose rate measurements on the inside of buildings. (auth)

18051 MICROBIOLOGICAL METHOD OF DETERMINATION OF THE SPECIFIC ACTIVITY OF THE RADIOACTIVE MATERIAL. Pluchennik, Henrik. Nukleonika, 11: 783-7(1966). (In Russian).

A new method of biological determination of specific activity of radioactive material based on isotopic dilution techniques is described. The linear correlation between the survival of microorganisms and the specific activity of the radioactive component of the medium were utilized. The method was considered to be applicable to those elements that are incorporated into the macromolecules of growing organisms. (auth)

18052 PORTABLE WHOLE-BODY COUNTER. Parker, Deray; Anderson, Jesse I. (Atomic Energy Commission, Idaho Falls, Idaho). Health Phys., 13: 141-8(Feb. 1967).

The routine whole-body counting program conducted during the past 5 years by personnel of the AEC Health and Safety Division at the National Reactor Testing Station has shown not only that whole-body counting is a reliable and sensitive method for the detection of internal γ-emitting nuclides, but that portable counters with minimal shielding are both adequate and effective in many practical programs of personnel monitoring. In the past, not enough emphasis has been placed upon both the desirability and practicality of using portable whole-body counters for monitoring under conditions in which the greater sensitivity of the heavily shielded laboratory-based counter is not required and the subjects to be counted must be transported considerable distances to the counter. A 650-lb portable counter is described, which has adequate sensitivity for detecting internal γ-emitting contaminants at levels well below the maximum permissible body burdens and can be moved easily to any desired location for use. Several programs involving the use of the portable counter are reported. Methods of calibration, details of construction and attendant costs are discussed. In most cases, the large, well-shielded laboratory counter using the conventional 50-cm arc technique is only twice as sensitive as the portable counter when used in its specified manner with the bell-shaped detector in contact with the body. (auth)

18053 MONITORING PERSONNEL DOSES. Wachsmann, F. (Univ., Erlangen, Ger.). Radiologe, 4: 359-62(Nov. 1964). (In German).

A discussion on the advantages and disadvantages of direct reading dosimeters as compared to those of film badges for radiation protection of personnel is presented. The advantages of using a

combination of film and an organic scintillator, such as terphenyl, are also discussed. (TSS)

18054 THE USE OF CLOSED CIRCUIT TELEVISION IN LASER INVESTIGATIONS. Fine, Samuel (Northeastern Univ., Boston); Klein, Edmund; Hardway, Glen; Scott, Ronald E.; King, William; Aaronson, Charles. J. Invest. Dermatol., 42: 289-91 (Apr. 1964).

Hazards accompanying use of laser radiation in biological studies are discussed and means of avoiding these hazards by use of television for viewing the effects of laser beams on biological specimens are described. Continuous observation of in vivo specimens is required prior to and during laser irradiation, particularly when precise focussing is attempted. Time is required to charge up the capacitor bank of a laser system, during which period the position of the animal may change. Since misfire may occur during charging, 15-60 sec elapse when direct viewing of the system should be avoided because of the hazards to the observer, particularly to the eyes and skin. It is important to make observations at the time of impact of laser radiation, and immediately thereafter, as part of the assessment of the local interactions and of the general responses. An inexpensive approach which provided information regarding the site of impact and the interaction, without hazard to the observer, was made possible by a closed circuit television. The TV pickup camera was located about 6 to 8 ft behind and to the side of a 300-J laser head. The camera was thus exposed to back-scattered radiation only and not to direct laser radiation. This arrangement allowed the biological system to be observed prior to, during, and after time of impact. Consequently, the general condition and location of the animal could be observed on the TV receiver, without danger to the operator either from the direct beam or from back-scattered radiation. In initial experiments the intensity of back-scattered radiation was such that damage occurred to the vidicon tube in the TV pickup unit, following exposure of the skin in the intact animal to laser radiation at an energy output of 300 J. (BBB)

18055 ^{137}Cs IN ALASKAN LICHENS, CARIBOU, AND ESKIMOS. Hanson, W. C. (Battelle-Northwest, Richland, Wash.). Health Phys., 13: 383-9(Apr. 1967).

Presented at the Annual Meeting of the Health Physics Society at Houston, Texas on June 27–30, 1966.

Cesium-137 concentrations in Alaskan arctic ecosystem components during the period 1962 to 1965 varied with seasonal and environmental conditions, emphasizing the important influence of ecologic factors upon fallout accumulation in the lichen–caribou (reindeer)–man food chain. Concentrations in lichens at Anaktuvuk Pass, Alaska, increased with time and varied among several species. Caribou flesh contained maximum ^{137}Cs levels during winter periods and lowest values during summer months, corresponding to lichen utilization. Body burdens in natives utilizing the caribou as a food base reflected the ^{137}Cs cycle in caribou flesh, but lagged by a few months. Maximum values occurred during summer and minimum values were found during mid-winter. Biological half-time of ^{137}Cs was estimated to be about 13 years in lichens (by measuring retention of ^{134}Cs artificially applied to natural lichen communities), three to five weeks in caribou and about 65 days in Eskimos. Cesium-137 concentrations increased by about a factor of two at each successive trophic level of the food chain. The trend with time was one of steady increase, although unusual variations occurred during 1964 and 1965 and were believed to be associated with caribou migration patterns. Recent data suggest ^{137}Cs body burdens of the Anaktuvuk Pass Eskimos will continue to increase during the summer of 1966 in contrast to the downward trend reported in Scandinavia. (auth)

18056 OFF-SITE RADIOLOGICAL SAFETY PROGRAM FOR PROJECT "DRIPPLE." Carter, M. W.; Harvey, H. D. Jr. (Dept. of Health, Education, and Welfare, Montgomery, Ala.). Health Phys., 13: 361-74(Apr. 1967).

The activities of the U. S. Public Health Service, Division of Radiological Health's Off-Site Radiological Safety Program in support of the "Salmon Event" of Project "Dribble" are described. Project "Dribble" is a part of the U. S. Department of Defense–U. S. Atomic Energy Commission's seismic research program called "Vela Uniform," which is designed to improve the United States' capability to detect, locate and identify underground nuclear detonations. The "Salmon Event" was the first of three proposed underground nuclear detonations for this project. Emphasis is placed on the types of environmental information and data gathered prior to the active test period, the establishment and maintenance of appropriate public relations in a relatively populous area, and the procedures utilized in the temporary evacuation of several hundreds of people who are residents of the area contiguous to the test site. Data obtained from the various monitoring projects conducted during the active test period and results of analyses of environmental samples collected after the "Salmon Event" are discussed. (auth)

18057 RADIATION HAZARDS AND RADIATION SAFETY STANDARDS IN MANNED SPACE OPERATIONS. Schaefer, H. J. (Naval Aerospace Medical Inst., Pensacola, Fla.). Health Phys., 13: 327-43(Apr. 1967).

Part of the material in this article was presented at the Houston meeting of the Health Physics Society, 28 June 1966.

The natural environment of ionizing radiation in space consists of three components: galactic radiation, trapped particles in the radiation belt, and solar particle beams. Whereas the exposure dose rate for the galactic radiation remains well below 100 mrad/24 hr, dose rates in the radiation belt may exceed 200 rad/hr. Still higher values can occur in solar particle beams. The energy spectra of trapped and flare produced particles are quite similar, exhibiting steep negative flux/energy gradients. As a consequence, exposure radiation levels and depth-dose distributions in the body depend sensitively on shielding. The fact that flare events occur essentially at random with only very limited prediction possibilities, together with the fact that space flight is an endeavor of high risk in general, would seem to call for a basically different philosophy of radiation protection in space. Even if one is prepared to allow substantially greater Maximum Permissible Doses (MPD's) or Radiation Protection Guides (RPG's) for manned space operations, the difficulty arises that critical dose levels for incipient deterioration of performance cannot be defined for the unique depth-dose distributions encountered in space radiation exposures. The dosage fields in the body, as they develop from trapped or flare produced particles vary, depending on shielding and spectral type, over a very wide range with Half Value Layers (HVL's) from less than 1-mm tissue to several centimeters. The fact that animal or human data on the effects of such total body exposures are missing constitutes a serious gap in present radiobiological knowledge for assessing the astronaut's exposure status in operational emergencies. (auth)

18058 EVALUATION OF FULL SCALE STRONTIUM REMOVAL SYSTEM FOR FLUID MILK. Fooks, J. H. (Dept. of Health, Education, and Welfare, Rockville, Md.); Terrill, J. G. Jr.; Heinemann, B. H.; Baldi, E. J.; Walter, H. E. Health Phys., 13: 279-86(Mar. 1967).

Five years of research in the laboratory and pilot plant have culminated in the successful design and operation of a full-scale commercial system for the processing of 100,000 lb of fluid whole milk per 8-hr day. This plant is fully automated (except for reuse of regenerant), constructed of stainless steel and other approved dairy industry materials meeting sanitary requirements. The process employs the fixed-bed ion-exchange principle based on results from a pilot plant in the Agricultural Research Center, Beltsville, Maryland, and the Sanitary Engineering Center in Cincinnati, Ohio. Nine test runs of 100,000 lb each have been made and have demonstrated that better than 90 per cent of the strontium can be removed from fluid whole milk without detracting from the flavor, sanitary quality or composition as a result of the treatment. No unusual processing problems were encountered and the process appears to be technically feasible on a large scale for emergency purposes. The contractor is developing information relative to the economic feasibility for commercial use. If the process is to be considered for routine use, further evaluation and clearances, such as approval by the Food and Drug Administration, of the resin for continued use may be necessary. (auth)

18059 ON THE LEGALISTIC ASPECTS OF THE RADIATION EXPOSURE RECORD. Hart, J. C. (Oak Ridge National Lab., Tenn.). Health Phys., 13: 319-26(Apr. 1967). (ORNL-P-2521).

Presented at the Eleventh Annual Meeting of the Health Physics Society, Houston, Texas, June 27–30, 1966.

Atomic energy installations have accumulated vast quantities of data for the radiation exposure record as a future interest matter and no small part of this accumulation has been for so-called legal reasons even though only a few legal precedents have been set in this particular area. Several rules have been laid down, or recommended by various agencies, but these are sometimes vague as to legal considerations or stated in broad terms because of the lack of uniformity in the laws of the various states. Specifically involved are the workmen's compensation acts, the wrongful death statutes, a consideration for property rights in certain types of personnel records, and the law of evidence. Dose data maintained for technical reasons are usually identifiable with the medical aspects of dose interpretation while dose data maintained for the legal record are associated with evidentiary problems in law. This study reviews some of the legal problems encountered and evaluates these problems in relation to current requirements and recommended practices. (auth)

18060 DEPOSITION OF NATURAL RADON DAUGHTERS IN HUMAN SUBJECTS. George, A. C.; Breslin, A. J. (Atomic Energy Commission, New York). Health Phys., 13: 375-8(Apr. 1967).

The fractional deposition in human subjects of natural radioactive particles has been determined by use of simple apparatus. This apparatus consists of a modifier filter respirator, rubber bag, sample filter holder, air flow meter, and air pump. A correction has been applied to deposition measurements to compensate for respirator "dead space." Preliminary measurements of the deposition of radon daughter products in four human subjects breathing New York City air are in the range 17.9–50.7 per cent. (auth)

18061 BASIS FOR ROUTINE URINE SAMPLING OF WORKERS EXPOSED TO ^{239}Pu. Beach, S. A.; Dolphin, G. W.; Duncan, K. P.; Dunster, H. J. (United Kingdom Atomic Energy Authority, Harwell, Eng.). Health Phys., 12: 1671-82(Dec. 1966). (AHSB (RP)-R-68).

A routine program for the measurement of plutonium in urine is discussed in relation to the other methods of controlling the internal radiation dose of those working with plutonium. The urinary excretion pattern following intakes of plutonium compounds is considered and a value for Q, the maximum body content applicable to all compounds, is proposed. A reference level and an action level for urinary excretion rates are suggested. Factors influencing the choice of sampling procedure and frequency are discussed. An example is given showing how the reference level and action level are used in a typical sampling program. Special mention is made of the managerial actions which are taken when a worker's urinary excretion rate exceeds the reference level and the action level. (auth)

18062 REMOVAL OF STRONTIUM FROM WATER BY ACTIVATED ALUMINA. Bonner, W. P.; Bevis, H. A.; Morgan, J. J. Health Phys., 12: 1691-1703(Dec. 1966).

Data are presented which show a mathematical model based on the law of mass action to be applicable to the description of strontium removal from solutions of low ionic strength by activated alumina. Using radiochemical techniques, the concentration of strontium and alumina, the presence of competing cations, total strength, and pH are shown to be the parameters controlling sorption. The use of activated alumina for removing strontium from natural waters indicates that greater than 90 per cent removal can be obtained when the concentration of calcium and strontium is within the range of concentrations normally found in water used for human consumption. (auth)

18063 DOSE RATE AND SPECTRAL MEASUREMENTS FROM PULSED X-RAY GENERATORS. Tochilin, E.; Goldstein, N. (Naval Radiological Defense Lab., San Francisco). Health Phys., 12: 1705-13(Dec. 1966).

Typical x-ray spectra from high intensity pulsed x-ray sources were determined by means of an equivalent constant voltage accelerator. The photon energy spectrum for the forward x-ray beam was measured with various x-ray target thicknesses at accelerator voltages of 1.0, 1.5 and 2.0 Mv. X-ray spectra were also obtained from a reflection x-ray target at angles of 7° and 45° with respect to the x-ray beam at applied potentials of 0.55, 1.0 and 2.0 Mv. The dose rate dependence of thermoluminescent LiF silver-activated phosphate glass, and dosimetry film was investigated over a range of dose rates extending from 10^4 to 10^{11} rad/sec with three separate flash x-ray systems. (auth)

18064 REDISPERSION OF SETTLED PARTICULATES. Fish, B. R.; Walker, R. L.; Royster, G. W. Jr.; Thompson, J. L. (Oak Ridge National Lab., Tenn.). pp 75-81 of Surface Contamination. New York, Pergamon Press, 1966.

The theory and experimental techniques needed to describe the redispersion of both radioactive and nonradioactive particulates are discussed. The redispersion tests were made using CuO, and nonradioactive CuO was detected by thermal-neutron activation analysis of the samples collected on the clothing of a person in a room. Some recommendations are made in operating control limits for a laboratory based on the surface contamination measured in the room. (B.L.M.)

18065 CONTAMINATION AND DECONTAMINATION OF EPOXY RESIN-BASE LACQUERS. Rotrekl, Bedrich; Lidarik, Miloslav (Research Inst. of Synthetic Resins and Lacquers, Czechoslovak Academy of Sciences, Pardubice). Jad. Energ., 12: 325-33(1966). (In Czech).

A series of epoxy resin-base lacquers were tested for susceptibility to radioactive contamination and for ease of decontamination. Epoxy 110EG8.5 and Epoxy 12 resins, hardened with B8 catalyzer, were found to have low wettability, high heat resistance, and the lowest susceptibility to contamination. Both are easily decontaminated. (ATD)

18066 HOT RADIOACTIVE PARTICLES. Herbst, W. (Univ., Freiburg i. B.). Vitalst. Zivilisationskr., 9: 119-21(June 1964). (In German).

Radioactive atoms that have agglomerated to form particles are known to be sources of extremely intense radiation. Studies indicated that hot particles that originated from dust of nuclear tests, which contain only 7×10^{-4} μC have a radiation dose effectivity of 60,000 R/hr at a distance of 0.001 mm and of 600 R/hr at a distance of 0.01 mm. Because of the incorporation of nonradioactive materials, the size of the particles is not directly related to the intensity of the irradiation. Molecular dispersions of radioactive rare gases and radioactive iodine also may be adsorbed by nonradioactive particles. The diameter of local fallout particles is ~1 mm, and the diameter of particles distributed worldwide is generally less than a few μ. The extent of biological significance of these particles depends on their total activity and whether they are inhaled, ingested, or deposited externally. Their water solubility frequently is different from their solubility in body fluids of tissues such as the lung alveoli. Inhaled particles may be deposited in the lymph nodes of the lung. Animal studies have indicated that increased frequency of carcinoma may follow inhalation of radioactive particles, where the radiation dose to the lung can range from 1000 to 3000 R. (BBB)

18067 URINARY EXCRETION OF ^{131}I-DIODRAST INJECTED INTRAVENTRICULARLY IN COMMUNICATING HYDROCEPHALUS AND AQUEDUCT STENOSIS. Grotte, Gunnar; Sjoegren, Irene; Sjoegren, Hakan (Univ. Hospital, Uppsala). Acta Paediat. Scand., 55: 211-16(Mar. 1966).

Estimations of the radiation dose to the patient were made in the course of studying nine cases of expansive infantile hydrocephalus by injecting small amounts of ^{131}I-Diodrast intraventricularly. Urinary excretion of the ^{131}I was determined during the first to 4 to 5 hr after injection. The cumulative excretion of Diodrast from the cerebrospinal fluid differs in cases with communicating hydrocephalus from those with stenosis of the aqueduct. The technique is rapid, easily performed, and has not produced any side effects. In calculating the concentration of Diodrast and the max dose given to the infant, the ventricular system was regarded as a sphere, the volume of which could be calculated when the skull circumference and the thickness of the brain parenchyma were known. The radioactivity of the ^{131}I-Diodrast injected varied between 0.4 and 5 μCi. One μCi or less was found to be sufficient. The max radiation dose was obtained by adding the doses due to β and γ rays given to the brain parenchymal in and surrounding the spherical liquor compartment in the theoretical case in which no transport of ^{131}I-Diodrast from the ventricles took place. In this case the effective half-time was equal to the half-time of the ^{131}I, which is 8 days. In this extreme case 1 μCi was calculated to give a dose of 200 ml. In fact, the effective half-time was considerably lower, especially in cases of communicating hydrocephalus, where the actual dose was less than 50 mrad. Repeated blood tests taken after the intraventricular injection of ^{131}I-Diodrast showed barely measurable radioactivity, demonstrating that the concentration of Diodrast in the blood was practically zero. All samples were measured in a well-type scintillation counter. The radioactivity remaining in the body was determined as a function of time by successively subtracting the excreted radioactivity from the injected radioactivity. In a semi-logarithmic diagram a straight line was usually obtained from 2 hr after injection and later, and the slope of that line was used to determine the biological half-time. (BBB)

18068 HAZARD TO THE DRINKING WATER SUPPLY IN CATCHMENT BASINS FROM HEAVY RADIOACTIVE FALLOUTS. Bernhardt, Heinz; Haberer, Klaus (Wahnbachtalsperrenverband, Siegburg, Ger.). Wasserwirtschaft, 53: 404-6(Nov. 1963). (In German).

Like all stored waters and lakes, drinking water catchment basins, because of their large surface, are very susceptible to contamination from radioactive fallout. Once contamination occurs it is retained for long periods by stored water and can increase further through addition of new activity, while in flowing water increased activities are usually of short-term duration. The evaluation of the dangers that threaten these waters from introduction of high concentrations of fresh U fission products is a measure necessary for protection of the drinking water supply. Under certain conditions it can be assumed that an atom bomb explosion will cause contamination of the stored water, without complete destruction of the water supply storage areas. The authors discuss the results of American studies on the activity found in waters located in the vicinity of areas where atomic bomb tests have been conducted. Concentrations of fallout measured have ranged from 10^5 to more than 10^6 pC/l. These values are compared with max permissible values that have been established. The composition of the fallout products found varies, ^{131}I being a major but decreasing hazard during the first 50 days. During the summer months the ^{131}I and other contaminants may be widely distributed throughout all depths of the water and many of these can be removed by chemical procedures. The ^{90}Sr contamination

represents the major hazard once the concentration of ^{131}I has decreased. (BBB)

18069 DOSIMETRY OF NATURAL IONIZING RADIATION. Solon, Leonard Raymond. New York, New York Univ., 1960. 112p.

Thesis.

Measurements have been made with ionization chambers to establish a representative sampling of the natural environmental radiation dosimetric profile over the United States. Total dose rate intensities have been analyzed into their principal constituent components i.e., the secondary cosmic radiation and the terrestrial gamma radiation. The purpose of these measurements was to contribute to the establishment of a base by which to compare departures in the natural ionizing radiation environment produced by manmade sources of radiation. These sources, which result from the medical and dental use of ionizing radiation, radioactive fallout from the testing of nuclear weapons, and disposal of radioactive wastes produced by the effluent of nuclear reactors, constitute recent perturbations in the natural radiation which always has been part of man's environment. A general discussion of dosimetric principles is given along with a description of devices which have been used for environmental radiation work. For the air-filled polyethylene-walled ionization chamber employed in this investigation, an experimental method for determining the adequacy of spectral energy response is described. This method utilizes reactor produced nuclides emitting essentially monoenergetic gamma radiation in their radioactive transitions. (Dissertation Abstr.)

Medicine

Refer also to abstracts 18158 and 18198.

18070 (NADC-ML-6508) FLASHBLINDNESS: THE EFFECTS OF PREFLASH ADAPTATION AND PUPIL SIZE. Hill, J. H.; Chisum, Gloria T. (Naval Air Development Center, Johnsville, Pa. Aviation Medical Acceleration Lab.). June 30, 1965. 14p. CFSTI $3.00 cy, $0.65 mn.

A question of considerable operational importance is the extent to which the blinding effect of a flash from a nuclear weapon will vary with the ambient light level. Under conditions of darkness the size of the pupil and the sensitivity of the eye are maximized. With an increase in the ambient light level both the sensitivity of the eye and the pupil size decrease. Data are presented on the independent effects of pupil size and receptor adaptation level on the production of flashblindness by high intensity, short-duration flashes. (auth)

18071 (RM-4725-TAB) SOME IMPLICATIONS OF UNCERTAINTIES IN THE HIROSHIMA EXPLOSION. Goeller, B. F.; Specht, R. D. (RAND Corp., Santa Monica, Calif.). Nov. 1966. Contract AT(04-3)-414. 39p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Uncertainty in the Hiroshima height of burst has a smaller effect on estimates of mortalities resulting from hypothetical nuclear attacks on urban areas in the United States than does, say, variation in the wind pattern assumed for the attacks. Uncertainty in the Hiroshima yield is of the same order of importance as variation in the wind pattern, while variation of the scaling exponent from $\frac{1}{3}$ to 0.4 is roughly twice as important as an uncertainty in the Hiroshima yield, say, between 11 and 20 KT. In counterforce attacks that are constrained to avoid collateral civil damage these uncertainties can have significant effects on collateral damage and on the selection of targets. (auth)

18072 (STI-PUB-100(Vol.2)) ATLAS OF RADIATION DOSE DISTRIBUTIONS. VOL. II. MULTIPLE-FIELD ISODOSE CHARTS. Cohen, M.; Martin, Susan J. (International Atomic Energy Agency, Vienna (Austria)). Aug. 1966. 310p. IAEA.

Isodose charts for multiple-field arrangements of high energy x ray beams, γ ray beams from ^{60}Co and ^{137}Cs units, and electron beams are presented in this volume. A homogeneous unit-density medium is assumed throughout. The charts are not intended for direct clinical use, but as framework for treatment planning and as a basis for analytical study. It is hoped that the atlas will also serve as a teaching manual and as a guide to what can be achieved with different types of equipment. To facilitate comparison between the charts, a high degree of uniformity is required and to this end certain conventions have been adopted, including a standard body outline and a reference level (100%) at the tumor rather than the surface. Over two-thirds of the charts relating to the x and γ rays were prepared specially for the atlas, with a step-by-step variation in the different parameters. These are mainly for fairly simple and symmetrical field arrangements. More complex and unusual arrangements are illustrated by charts based on actual treatment plans obtained from various radiotherapy institutes; these charts have been redrawn to conform with the style and conventions of the atlas. (auth)

18073 (SZS-8/66) RICHTLINIEN FUER DIE DIAGNOSTIK UND THERAPIE VON AKUTEN STRAHLENSCHAEDEN. (Guidelines for the Diagnosis and Therapy of Acute Radiation Injuries). EMPFEHLUNGEN FUER DEN ARZT ZUR AUSSCHLIESSUNG VON DER ARBEIT UNTER EINWIRKUNG IONISIERENDER STRAHLEN. (Recommendations for Doctors for Exclusion of the Work on Action of Ionizing Radiation). Geipel, R.; Morczek, A.; Raube, D.; Schuettmann, W.; Sitzlack, G.; Thiele, H.; Zeuner, A. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Aug. 1966. 32p. (In German). Dep. mn.

An outline of the diagnosis and therapy of acute radiation injuries is presented. The circumstances under which a doctor can grant exemption from work for workers exposed to ionizing radiation are described. (J.S.R.)

18074 (TID-23518) STUDY OF FEASIBILITY OF UTILIZING RADIOACTIVE MICROSPHERES FOR THE TREATMENT OF MALIGNANT TUMORS. [Progress Report]. (Minnesota Univ., Minneapolis. Medical School). Jan. 16, 1967. Contract AT(11-1)-1305. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on studies conducted on dogs and rabbits on the feasibility of using radioactive plastic microspheres for the interstitial therapy of malignant tumors. Studies in rabbits showed that neither 5-fluorouracil nor nitrogen mustard increased the effects of arterially injected ^{90}Y microspheres on suppression of growth of transplanted carcinomas in the liver. Efforts to irradiate the liver of dogs by microspheres injected into the hepatic artery were not successful. It was concluded that the intravascular introduction of radioactive microspheres for hepatic irradiation is not warranted for clinical application using present techniques. Gastric irradiation of dogs was carried out by the introduction of microspheres containing ^{90}Y or ^{32}P into the arterial blood supply of the stomach. It was concluded that the technique offers a means of delivery of a large dose of β radiation to the stomach. Injection of ^{90}Y into the splenic artery of dogs and rats induced a moderate lymphopenia in peripheral blood. Homografts of skin applied to lymphopenic rabbits persisted longer than homografts applied to untreated rabbits. The growth of carcinoma after injection of tumor cells into the thigh or ear vein was not affected by spleen irradiation in animals examined 28 days after tumor injection. Data are included on the tissue distribution of microspheres following injection into arteries, the radiation dose received by the target organ, and the radiation dose received by adjacent tissues. (C.H.)

18075 (USNRDL-TR-67-4) INCREASED RADIATION RESISTANCE OF MICE INJECTED WITH BEE VENOM ONE DAY PRIOR TO EXPOSURE. Shipman, W. H.; Cole, L. J. (Naval Radiological Defense Lab., San Francisco, Calif.). Dec. 20, 1966. 19p. CFSTI $3.00 cy, $0.65 mn.

Mice were injected with bee venom dissolved in a 0.90% NaCl solution. This injection was given either intraperitoneally or subcutaneously 24 hours before the mice were irradiated with x rays. It was found that, after exposure to a lethal dose of radiation (800 to 850 R) the venom-injected mice had a consistently higher number of survivals than the controls, and that the subcutaneously-injected mice had a higher number of survivals than the intraperitoneally-injected mice. The question as to whether this radioprotective effect of bee venom is due to its general stress-like effect, or to the action of a specific chemical component was discussed. (auth)

18076 INCREASE IN THE CONTENT OF ENDOGENOUS SULFHYDRYL COMPOUNDS AS THE MECHANISM OF RADIOPROTECTIVE ACTION. Graevskii, E. Ya.; Konstantinova, M. M.; Nekrasova, I. V.; Sokolova, O. M.; Tarasenko, A. G. (Inst. of Animal Morphology, Moscow). Nature, 212: 475-7(Oct. 29, 1966).

The effects of radioprotective agents on the concentration of sulfhydryl groups in mouse tissues and in cells of Ehrlich ascites carcinoma were determined. Sulfhydryl content was determined in spleen homogenates following injections of cysteamine, cystamine, AET, or serotonin in living mice or in dead animals 5 min after death by anoxia. A distinct increase (between 10 and 35%) was noted in the concentration of sulfhydryl groups. Concentrations of sulfhydryl groups in cells from the abdominal cavity of animals killed by anoxia and from living mice treated with 5 mg cystamine 15 min prior to determination was considerably higher (by 17 and 12% respectively) than in tumor cells from untreated mice. The increase in tissues of cystamine- and cysteamine-treated animals was observed only when the agent was injected in vivo. Contact of ascites tumor cells with homogenate derived from anoxic spleen 15 min before irradiation distinctly diminished the radiation damage in the tumor cells and decreased the proportion of cells with chromosome aberrations. It is pointed out that the increase in the

concentration of sulfhydryl groups cannot be attributed to the presence of such groups in the protector injected. Further, lability of the sulfhydryl groups appearing in the protected tissues suggests that they are not derived from sulfur-containing amino acids. It is concluded that the mechanism of radioprotection of the agents is associated with an increase in the amount of sulfhydryl groups under conditions of anoxia, an effect that may be explained by oxidation of thiol groups that continuously appear as a result of spontaneous reduction of −S−S− bonds. The mechanism by which highly labile sulfhydryl compounds attenuate radiation damage in biological materials seems most likely to be the inactivation of radiolytic products of biomacromolecules important to the viability of the cell, and then return of these products to their native state. (H.G.D.)

18077 OSTEONECROSIS AND SARCOMA FOLLOWING EXTERNAL IRRADIATION OF INTRACEREBRAL TUMORS. Berg, N. O.; Landberg, T.; Lindgren, M. (Univ. of Lund, Sweden). Acta Radiol., Therapy, Phys., Biol., 4: 417-36(Dec. 1966).

Radionecrosis of the skull in 16 patients is described. The condition was more common after irradiation of children and young people, and the changes were not related to surgical trauma or the radiation dose delivered. A consideration of two patients with sarcoma of the skull suggested that soft tissue swelling or progression of cranial necrosis five years after irradiation or later indicated a malignant change. (auth)

18078 SHORT-SPAN ^{60}Co RADIOTHERAPY OF LUNG CARCINOMA WITH SIMULTANEOUS OXYGEN INHALATION AND BLOCKING OF PULMONARY ARTERY. Notter, G.; Nordenstroem, Bj.; Norhagen, Ake; Jakobsson, Per A. (Karolinska Sjukhuset, Stockholm). Acta Radiol., Therapy, Phys., Biol., 4: 494-510(Dec. 1966). (In German).

Radiotherapy of bronchial carcinoma with simultaneous intermittent occlusion of the pulmonary artery and inhalation of oxygen at ordinary atmospheric pressure has been performed for the first time. The application of a catheter with an inflatable cuff, previously described, results in higher oxygen saturation and possibly increased radiosensitivity in the tumor bed. The catheter method enabled the period of treatment to be shortened to between 9 and 14 days: the total tumor dose was 4500 rad and the catheter remained in the pulmonary artery for a maximum period of 15 days. A continuous drip of heparine-glucose and rheomacrodex was employed to prevent thrombosis. The investigation has demonstrated the feasibility of intermittent occlusion of the pulmonary artery during oxygen inhalation and of the short-span radiotherapy of cases suffering from advanced bronchial carcinoma. (auth)

18079 HYDROXYUREA: EFFECTS OF CHINESE HAMSTER CELLS GROWN IN CULTURE. Sinclair, Warren K. (Argonne National Lab., Ill.). Cancer Res., 27: 297-308(Feb. 1967).

The lethal and inhibitory actions of the drug make it a useful synchronizing agent in asynchronous populations, even though the length of the S period may be slightly reduced thereafter. Furthermore, although inhibited cells are more sensitive to x-rays in the presence of the drug, they recover normal x-ray responses within a short time after the drug is removed. (C.O.)

18080 RELATIONSHIPS OF RADIOPROTECTIVE AND ANTICANCER PROPERTIES OF INHIBITORS OF RADICAL PROCESSES. Burlakova, E. B.; Gaintseva, V. D.; Emanuel, N. M. (Inst. of Chemical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Biol., No. 4, 511-16(July-Aug. 1966). (In Russian).

Relationships between radioprotective and anticancer properties of inhibitors of radical processes were established. Concentration thresholds of the preparations used were determined at the levels the inhibitors showed predominance in either radioprotective or anticancer properties. It was also demonstrated that at certain concentrations inhibitors of radical processes possessed both properties. (auth)

18081 POST-IRRADIATION RECOVERY OF CELLS OF MAMMALS. Paribok, V. P. (Inst. of Cytology, Leningrad). Tsitologiya, 9: 137-51(Feb. 1967). (In Russian).

At the site of ionizing radiation the repair of sublethal injuries of cells in culture started immediately after irradiation; there was complete recovery in the surviving cells. Recovery continued to occur after repeated irradiation. The repair process was not affected by low temperatures and did not seem to require oxidative metabolism. Radioinduced chromosome aberrations and gene mutations were reversible. Cells injured by α irradiation did not recover. Neither photoreactivation nor dark reparation was observed in uv irradiated cells. Possible future research problems on post-radiation recovery of mammalian cells are discussed. The importance of studying lethal injury is pointed out. (H.L.W.)

18082 LASER THERAPY OF MELANOMAS. Goldman, Leon; Siler, V. E.; Blaney, Donald (Children's Hospital Research Foundation, Cincinnati). Surg. Gynecol. Obstet., 124: 49-56(Jan. 1967).

Effects of ruby (6943 Å) and neodymium (10,600 Å) laser radiation on melanomas in animals and in 9 patients are reported. Laser irradiation was seen to produce local coagulation necrosis in melanomas. Lesions were observed to char, ulcerate, flatten, disappear or recur. The microscopic sections showed early coagulation necrosis in the target area with no change in the adjacent tumor; later increased melanin and melanocytes developed. Nonspecific fibrosis developed later. This was either complete or contained occasional foci of melanin extracellularly or in phagocytes. Foci of melanoma also were found amid scar tissue. The effects of equivalent energy densities of the ruby and neodymium lasers were the same. It was shown that if the energy density was adequate, at least 2000 to 3000 J/cm^2, and if the target area coverage was adequate, local lesions could be destroyed. The selective effect of the laser beam was shown in that the laser beam could be used without damage to adjacent vital structures. The selective effect of color in regard to absorption of the laser beam was also demonstrated. (TSS)

18083 RADIOBISMUTH (^{206}Bi) FOR GAMMA ENCEPHALOGRAPHY OF BRAIN TUMORS. Mundinger, F.; Asai, A.; Gerhard, H.; Gabriel, E. (Univ., Freiburg i. B.). pp 497-500 of Proc. Third Intern. Congr. Neurol. Surg., Aug. 23–7, 1965, Copenhagen. Amsterdam, Exerpta Medica Foundation, 1966.

A method for using ^{206}Bi citrate to detect brain tumors was developed and evaluated clinically. A pure γ spectrum of between 0.18 and 1.7 MeV is emitted by ^{206}Bi. Its half-life period is 6.4 days, and its high accumulation in tumors makes it suitable for γ encephalography. After intravenous injection of ^{206}Bi citrate the brain tumor ratio was 49.8 in Jensen's sarcoma of the rat, 113.0 in dimethylaminostilbene carcinoma, and, 32 in the dedifferentiated glioma of the mouse. In biopsy material of human brain tumors accumulation of ^{206}Bi was between 12 and 32 times higher than that in normal brain tissue. Since the complex γ spectrum of ^{206}Bi makes scintigraphic demonstration of enrichment foci extremely difficult, a method of digital measurement was used after a dose of 4.25 μC/kg was intravenously injected. Count rates of a discriminated spectrum of between 390 and 900 keV were measured over 17 measuring fields on either side of the head. Most tumor types could be distinguished by their individual variation in activity in the period between 1 and 24 hr. Of the 570 scans with ^{206}Bi, the results with 76 tumors were operatively and histologically verified. In 79% of the patients not only the location of the tumors but also their classification was exactly determined. In another 15% the site of the tumor was correctly shown but a diagnosis of type was not possible. It was also possible to recognize tumor recurrences, cysts, intracerebral hematomas, hemisphere displacement of subdural hematomas, disturbances of the capillary barrier after trauma, and local disturbances of blood supply. (BBB)

18084 LATE RESULT OF A CASE OF CUSHING'S SYNDROME OF CENTRAL ORIGIN TREATED BY INTRAHYPOPHYSIAL RADIOACTIVE GOLD. CONSIDERATIONS OF THE FUNCTIONAL HYPOPHYSIAL INTEGRITY. Klotz, H. P.; Stancu, H. (Hopital Beaujon, Clichy, France). Ann. Endocrinol. (Paris), 26: 443-6 (July–Aug. 1965). (In French).

The effect of ^{198}Au hypophysial implantation on various clinical and biochemical parameters is reported with reference to a case of Cushing's disease. A 24-mCi pellet of ^{198}Au was implanted in the pituitary of the 19-yr-old woman. The urinary excretion of 17-ketosteroids, elevated to 19 mg/24 hr before treatment, fell to 3.5 mg/24 hr one month after ^{198}Au implantation and to 3.0 mg/24 hr three years later. The 17-hydroxycorticosteroid level fell from 13 mg/24 hr to 1.0 and 3.5 at one month and three yr post-treatment. Cholesterol level fell from 300 to 150 and 120 mg/l at these intervals. Normalization of Na, K, and Cl excretion occurred, as did numerous other indices of pretreatment hyperactivity of the pituitary. The metopyrone test was positive, showing residual pituitary reactivity but only weak reserves of ACTH. Antithyroid tests revealed lowered pituitary reserves of thyrotropin as well. Successful control of the disease was achieved. (BBB)

18085 ^{113m}In: A SHORT-LIVED ISOTOPE FOR LUNG SCANNING. Stern, H. S. (Johns Hopkins Medical Institutions, Baltimore); Goodwin, D. A.; Wagner, H. N. Jr.; Kramer, H. H. Nucleonics, 24: No. 10, 57-9(Oct. 1966).

Development and use of ^{113m}In hydroxide and ^{113m}In-labeled iron hydroxide for lung scanning are discussed. Although ^{113m}In hydroxide had many desirable characteristics as a scanning agent, it proved to be toxic. The ^{113m}In labeled iron hydroxide was found in clinical and experimental studies to have more desirable biological properties in addition to giving a lower radiation dose than ^{131}I. (H.G.D.)

18086 ^{137m}Ba COW: A NEW SHORT-LIVED-ISOTOPE GENERATOR. Blau, Monte; Zielinski, Rita R.; Bender, Merrill A. (Roswell Park Memorial Inst., Buffalo). Nucleonics, 24: No. 10, 60-2(Oct. 1966).

A radioisotope generator is described that produces ^{137m}Ba in yields of about 50% and trace amounts of ^{137}Cs. Separation of the two radioisotopes is achieved by microcrystalline ammonium molybdophosphate. Dosimetry and uses of the ^{137m}Ba from the cow are considered. The whole-body dose was calculated to be <0.5 mrad per mCi injected. The ^{137m}Ba from the cow was particularly useful in the study of vascular dynamics and provided an effective technique for measuring resolving time of counters. (H.G.D.)

18087 THE INFLUENCE OF ANOXIA ON THE GUINEA PIG SUBJECTED TO HEMILETHAL DOSES OF ROENTGEN RAYS. I. STUDY OF SURVIVAL AND BODY WEIGHT, OF PONDERAL VARIATIONS, AND OF HISTOLOGICAL CHANGES OF CERTAIN ORGANS. Meldolesi, U.; Mazzella, G.; Paolucci, G. (Univ., Catania, Italy). Riv. Med. Aeron. Spaziale, 24: 407-23(July–Sept. 1961). (In Italian).

Experiments were conducted in guinea pigs subjected to hypoxia and x radiation. Hypoxia was induced by forcing the animals to breathe a 6.6% O_2–93.4% N_2 mixture for 15 min before, 18 min during, and 30 min after irradiation. A 360-R dose ($LD_{50/30}$) of x rays was used. The survival curves of guinea pigs breathing air and those breathing the hypoxic mixture were similar; at 13 days postirradiation, the respective survival rates were 56 and 55%. Decreases in body weights were slightly less in the hypoxic group, as were decreases in the weight of liver, spleen, and testes; differences were not significant. Histologic examination of these three organs did not reveal any differences between the two groups. It was concluded, on the basis of the parameters studied, that hypoxia as produced in these experiments did not confer any appreciable degree of protection against whole-body x-irradiation. (BBB)

18088 TREATMENT OF CANCEROUS EFFUSION. Ariel, Irving M.; Oropeza, Ruben; Pack, George T. (Pack Medical Foundation, New York). Progr. Clin. Cancer, 2: 185-92(1966).

Complications are reported as occurring after the implantation of radioisotopes (^{198}Au and/or $^{32}CrPO_4$) for either fully or partially controlling cancerous effusion within the thoracic and abdominal cavities. In 267 patients receiving a total of 325 implantations, benefit was obtained in 54%. In patients given the radioisotopes intrapleurally, nausea occurred in 25%, transient vomiting in 5.0%, and low-grade fever of 2 to 3 days duration in 5.0%, and about 5.0% of patients complained of an ill-defined feeling of weakness and "sickness". No respiratory symptoms were observed and there was no compromise in ventilatory function. In patients given the isotope intraperitoneally, 35% suffered transient nausea and in 12% vomiting occurred; 10% of patients had mild diarrhea and 13% suffered a low-grade transient fever. A reaction of the site of injection, possibly due to faulty technic, was observed in 2.0%; in 5.0% localized intraabdominal pain and tenderness occurred, believed due to the injection of some of the material into either the omentum or other solid tissue. Symptoms of peritonitis, so-called sterile or plastic peritonitis, developed in 1.5% of patients and was particularly observed where either previous chemotherapy and/or external radiation therapy had been given, but was not apparent in those treated solely with radioisotopes. Radioyttrium, ^{90}Y, was used in 10 patients and finally abandoned because it was not superior to the other isotopes, and unless administered with carrier-free Y, it is absorbed and may produce serious clinical sequelae. Yttrium-90 microspheres were given to 20 patients with cancerous seeding of the pelvic floor and diaphragmatic pleura. The microspheres gravitated toward the most dependent position, and increased irradiation of those tissues could be obtained. (BBB)

18089 CAUSES OF RAPID AND EARLY DEATHS OF PATIENTS WITH CARCINOMA OF THE UTERINE CERVIX AFTER RADIOTHERAPY IN MATERIAL OF THE INSTITUTE OF ONCOLOGY IN GLIWICE. Witkowski, Feliks; Hliniakowa, Irena; Wozniakowska, Zofia (Inst. of Oncology, Gliwice, Poland). Nowotwory, 16: 359-62(Oct.-Dec. 1966). (In Polish).

Out of 1817 autopsies performed in the Institute of Oncology in Gliwice in the years 1947–1963, 165 concerned patients with carcinoma of the uterine cervix. Among them 38 cases were rapid and early deaths (in the course of the radiation treatment) not caused by the neoplasm. Of 11 cases of rapid death during radiation treatment of carcinoma of the uterine cervix, all were caused by pulmonary artery emboli. The starting point of the emboli was always coagulation phlebitis of deep veins of legs and of the iliac vein. Early death occurred in 27 cases, most common cause of early death was peritonitis, most commonly adnexitis was the starting point of the infection. (auth)

18090 ^{113m}In FOR BLOOD-POOL AND BRAIN SCANNING. Stern, H. S. (Johns Hopkins Medical Institutions, Baltimore); Goodwin, D. A.; Scheffel, U.; Wagner, H. N. Jr.; Kramer, H. H. Nucleonics, 25: No. 2, 62-5; 68(Feb. 1967).

Mice were injected with ^{113m}In in a solution of pH 4.0 with a 2% gelatin concentration. Fifty to sixty per cent of the injected radioactivity remained in the blood after 3 hr, and there was only a 20% fall in concentration of radioactivity during the period between 10 min and 2 hr after injection. The rest of the activity was found in the liver, kidney, and lung. Similar results were obtained in dogs. High blood levels were obtained for 3 hr after intravenous injection. The safety of the method was increased by the use of carrier-free ^{113m}In; methods of preparing carrier-free ^{113m}In are described. Figures are presented to show the biological half-life in the blood of two patients who had heart scans to determine the possibility of a pericardial effusion. The half-times were 2 and 3.5 hr. To determine binding sites in blood, ^{113m}In solutions with human plasma were incubated at room temperature and electrophoresis was carried out. Nearly all of the radioactivity was associated with the beta-globulin fraction. Figures are presented to show heart and placental scans after injection of ^{113m}In. Compounds of ^{113m}In were developed for brain scanning. Methods of complexing ^{113m}In with DTPA and EDTA are described. Tumor bearing mice were injected with the DTPA compound and sacrificed 10 min to 2 hr later to determine the distribution in the tissues. The tumor-to-brain ratios approached 23:1 at 2 hr. The blood level was highest at 10 min and decreased afterwards. The compound was studied in several patients with brain tumors that had been visualized with $^{99m}TcO_4$ and it was found that the brain scans made with ^{113m}In–Fe DTPA compared well with those made with technetium. Experiments with the EDTA compound showed that the tumor uptake and blood disappearance paralleled observations with the DTPA compound. (H.L.W.)

18091 THE USE OF THE JENA 30-MeV BETATRON IN RADIATION THERAPY. Kriester, A.; Geske, G.; Nitsch, G. (Friedrich-Schiller-Univ., Jena, Ger.). Radiobiol. Radiotherap., 7: 437-42(1966). (In German).

The use for medical purposes of bremsstrahlung of a 30-MeV-betatron that was developed and built for physical-technical purposes is reported. The additional equipment necessary for the use of the betatron in radiation therapy is described and the characteristics of the beam are illustrated by means of dose curves. From the results of measurement the different radiation doses in betatron and cobalt irradiations are pointed out. Planned extension of the irradiation program with ultrahard x radiation and fast electrons is represented. (auth)

18092 CHEMICAL PROTECTION AGAINST DOMINANT LETHAL MUTATIONS INDUCED BY X RADIATION IN MOUSE MALES. Pomerantseva, M. D. (Inst. of General Genetics, Moscow). Genetika, No. 1, 102-13(Jan. 1967). (In Russian).

The efficiencies of three protectors against dominant lethal mutations induced by x radiation in male mice were determined. The drugs used were 5-metoxytryptamine (mexamine), β-aminoethylisotiuronium (AET), and β-aminoethylthiophosphate (cistaphos). These substances exhibited a good performance at the organism level. 5-metoxytryptamine proved to be the most effective protector. The protective effect of mexamine depended on the spermatogenesis stage at the time of irradiation and on the irradiation dose. At a dose of 400 R the highest protective effect was observed at the spermatocyte stage (protection coefficient –0.39). The protection rate at the spermatid stage was slightly lower (protection coefficient –0.24). No protection effect was observed when mature spermatozoa were irradiated with this dose. At a dose of 200 R mexamine had a protective effect only at the spermatocyte stage (protection coefficient –0.38). At a dose of 600 R only a slight protection of spermatozoa was perceptible (protection coefficient –0.16). When AET was used, the protective effect, at a dose of 400 R, was only observed at the spermatocytes stage (protection coefficient –0.33). Cistaphos had no protective effect at any stage of the spermatogenesis. All the effective protectors reduced the death rate both prior to and after the implantation. (auth)

18093 SCINTIGRAPHY OF THE LIVER WITH ^{99}Mo-LABELED SODIUM MOLYBDATE. Strietzel, M.; Hennig, K.; Woller, P.; Wagner, G. (Medizinische Akademie Carl Gustav Carus, Dresden. Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Fortschr. Geb. Roentgenstr. Nuklearmed., 105: 664-9(Nov. 1966). (In German).

After a brief discussion of the physical features of sodium-molybdate and some remarks on its metabolic behavior an account is given experiences in the scintigraphy of the liver with ^{99}Mo sodium molybdate. The most favorable time for taking the scintigram must not be missed. It is emphasized that the simultaneous presentation of the kidneys and the absence of an uptake in the gallbladder might lead to errors. The method is suitable for the diagnosis of destructive liver processes. (auth)

18094 ^{99m}Tc MACROAGGREGATED ALBUMIN: A NEW LUNG SCANNING AGENT. Peterson, C. C.; Bonte, F. J. (Univ. of Texas, Dallas). Int. J. Appl. Radiat. Isotop., 18: 210-2(Mar. 1967).

Preliminary studies using macroaggregated human serum albumin (MAA) tagged with technetium-99m for lung scanning in rabbits are very encouraging. No problems were encountered in the preparation of the ^{99m}Tc tagged macroaggregates, and, as might be predicted, the administration of the prepared macroaggregate suspension results in very selective localization of activity in the lungs and high counting rates. Because of the extremely favorable 6 hr half-life and low photon energy of this isotope, large doses may be used to provide a counting rate that will facilitate rapid scanning, while reducing total patient radiation exposure. For these reasons it appears that MAA tagged with ^{99m}Tc may be the preferred agent for lung scanning. (auth)

18095 PARTICLE ACCELERATORS IN RADIOTHERAPY. Botti, G.; Romussi, M.; Tosi, G. (Clinica Sant'Ambrogio, Milan). Energ. Nucl. (Milan), 14: 172-7(Mar. 1967). (In Italian).

A short analysis is performed of the main technical problems concerning the right irradiation of a neoplastic center source. The possibilities of the various accelerator types and the corresponding practical utilization procedures in radiotherapy are critically reviewed, with particular regard to linear accelerators, betatrons and synchrocyclotrons. (auth)

18096 SOME CLINICAL OBSERVATIONS ON THE TOXICITY OF RADIOACTIVE SUBSTANCES FOLLOWING THE CONTAMINATION OF WOUNDS WITH ^{131}I, ^{32}P, AND ^{24}Na. (EXPERIMENTAL STUDY). Brebeanu, Gh. Rev. Sanit. Mil., 62: 887-900(Sept.-Oct. 1966). (In Rumanian).

In an experimental study involving 3 lots of 12 guinea pigs each, the author found that the harmful effect of radioactive iodine after contamination of a wound without surgical processing is quite small even at relatively high dosages but that radioactive phosphorus and radioactive sodium have a pronounced effect under the same conditions. (CFSTI)

18097 APPLICATION OF THE RADIOPROTECTIVE SUBSTANCE AMINOETHYLISOTHIOUREA Br IBr (AET). Pospisil, J.; Dienstbier, Z.; Kotatko, J. (Charles Univ., Prague). Cas. Lek. Cesk., 105: 1165-71(Oct. 28, 1966). (In Czech).

Betaaminoisothiourea (AET) of Czech and USA origin was administered to mice, rats, and dogs, and its effect investigated. The effect of the two substances is basically similar, and there is no great difference in their toxicity. AET administration before irradiation is not effective; its toxicity is too high for use in treatment of human beings. (CFSTI)

18098 STUDIES ON TELECOBALT THERAPY. A NEW MOVING COLLIMATOR DEVICE. Okajima, Shunzo (Nagasaki Univ., Japan). Nippon Igaku Hoshasen Gakkai Zasshi, 24: 180-82(May 25, 1964). (In Japanese).

A new moving collimator device was attached to a ^{60}Co rotating teletherapy unit. Ellipsoidal dose distributions in any shape (axial ratio), size, and direction were made by adjustment of variable resistance. Operation of the unit was very simple. It was concluded that the modified unit met the requirements for use in clinical therapy. (auth)

18099 HEMOPOIESIS-PROMOTING EFFECT OF ENDOTOXIN IN IRRADIATED ANIMALS. Smith, Willie W. (National Cancer Inst., Bethesda, Md.). pp 205-10 of Bacterial Endotoxins, Proceedings of a Symposium, Rutgers, The State Univ., New Brunswick, N. J., 1963. New Brunswick, Rutgers, 1964.

Studies in guinea pigs and mice showed that a single injection of bacterial endotoxin increases survival when given either before or shortly after irradiation in the dose range associated with death from hemopoietic damage. The effect of endotoxin on survival, granulocyte and lymphocyte counts, and hemoglobin concentration in guinea pigs and mice injected before or within the first half-hour after whole-body x irradiation is reported. (TSS)

18100 THE USE OF RADIOACTIVE PHOSPHORUS ^{32}P AND A MINIATURE GEIGER COUNTER TO DETECT MALIGNANT NEOPLASIA OF THE RECTUM. Nelson, Robert S.; Lanza, Frank L. (Univ. of Texas., Houston). Amer. J. Proctol., 17: 221-8(June 1966).

Clinical tests were conducted preliminary to developing a new radioisotope technic for detecting rectal cancer. These tests employed ^{32}P and a miniature Geiger counter in the evaluation of rectal lesions and represent the first attempt to use this means of diagnosis in a large number of patients. With dimensions of 25 × 5 mm, with a sensitive area of 5 × 10 mm, one Geiger tube had an intrinsic efficiency of about 50% for detecting ^{32}P β particles. The other tube, considerably larger (2.15 × 0.255 in), and with 80% efficiency in detecting β particles was used more often than the smaller one. The patients were given 500 μC of ^{32}P intravenously 18 to 20 hr before the examination. With the proctoscope fully inserted, the probe was passed and readings taken at 2 to 3 cm intervals throughout the bowel by retracting the scope with the counter tube projecting. For proven malignant neoplasia, the decision as to accuracy of the testing was based upon the correlation of a histologically proven lesion with at least a 30% increase in counting rate above that seen in the adjacent control area (100 to 200 cpm). In non-neoplastic disease, or benign neoplasia, the lack of an increase in counting rate was correlated with negative biopsy specimens. In most positive tests the counting rate over the tumor area ranged from 30 to 200% higher than that over the control areas. In 50 tests carried out in 49 patients by scanning the rectum with a small Geiger counter tube inserted through the proctosigmoidoscope, the overall accuracy was 90%. The method is of value in the differentiation of benign inflammation from malignant infiltration, in detecting malignant change in villous adenomas, and in the differentiation of atypical-appearing malignant infiltrations of all kinds. The technique is relatively simple and inexpensive. (BBB)

18101 ISOLATION STOMA COLOSTOMY AND RADIATION-INDUCED RECTOVAGINAL FISTULA. Hodgkinson, C. Paul; Baker, R. H. (Henry Ford Hospital, Detroit). Amer. J. Obstet. Gynecol., 96: 73-9(Sept. 1, 1966).

Favorable results were obtained when isolation stoma colostomy was used as initial treatment in 14 patients with extensive rectovaginal fistulas, all but one of which were radiation induced. Isolation stoma colostomy refers to a modified colostomy in which the distal colon stoma is either primarily closed or widely separated from the proximal colon stoma. Radiation-induced rectovaginal fistulas were classified on a pathology-time basis (malignant or non-malignant, and dynamic or static) and for each classification colostomy objectives are considered. Fistulas which result from radiation-induced degeneration of malignant infiltration of the rectovaginal septum are unpreventable and because they remain pathologically active are seldom curable. Non-malignant rectovaginal fistula incidental to radiation therapy results mainly from use of radium, with excessive irradiation of the rectovaginal septum. They occur by the process of avascular necrosis and may develop months to years after completion of radiation therapy. Clinical symptoms and pathology of the various types of injury are presented, and the surgical technique is described in detail and illustrated. In 6 patients with malignant rectovaginal fistula, palliation was obtained which ranged from moderate to excellent. Of 7 nonmalignant fistulas treated by isolation stoma colostomy, 3 healed spontaneously without operation, and 4 healed primarily without infection after operative resection. (BBB)

18102 RADIOTHERAPY WITH MOVING-STRIP TECHNIQUE FOR TESTICULAR TUMORS METASTATIC TO THE LUNGS. Simon, Norman; Winsberg, Fred; Rotman, Marvin; Silverstone, Sidney M. (Mt. Sinai Hospital, New York). J. Amer. Med. Ass., 197: 759-61(Sept. 5, 1966).

A moving-strip telecobalt radiotherapy technic was used to irradiate the entire thorax for pulmonary metastases from testicular carcinomas. Although not ordinarily considered radiocurable, these tumors responded favorably. The technic consists of treating a large volume of tissue in parallel opposing successive strips, delivering a dose equal to that which the large volume could tolerate, but in less time. Thus, for example, instead of treating the whole abdomen to 3000 rad in 6 or 7 weeks, a midplane dose of about 3000 rad is delivered to each segment in 12 treatment days. The patients tolerated the treatments unusually well, but radiation damage to the lungs developed, mild in the patient surviving 3½ years, and more severe in the other one. The latter patient is surviving without evidence of tumor 1½ years after treatment. Despite the relatively high doses delivered to the whole thorax, the first patient had only minimal pulmonary fibrosis. Although the fibrosis was more extensive in case 2, it was only in areas which received double treatment. Even though testicular tumor metastatic to the lung may be controlled by radiation, the radiation dose required may be lethal. When the dose with the moving strip method was kept below 3000 rad in 12 days, serious pulmonary fibrosis appeared to be avoided. (BBB)

18103 PRECONCEPTION, INTRAUTERINE, AND POSTNATAL IRRADIATION AS RELATED TO LEUKEMIA. Graham, Saxon (State Univ. of New York, Buffalo); Levin, Morton L.; Lilienfeld, Abraham M.; Schuman, Leonard M.; Gibson, Robert; Dowd, John E.; Hempelmann, Louis. Nat. Cancer Inst. Mongr., No. 19, 347-71(Jan. 1966).

Reports on the relation between various kinds of exposure to radiation and childhood leukemia are reviewed, most of them considering exposure of the fetus to diagnostic irradiation in utero, or diagnostic or therapeutic postnatal irradiation. Because of the

variables, conflicting positive and negative findings have resulted. Data for 319 children with leukemia from upstate New York and the metropolitan and rural areas around Baltimore and Minneapolis–St. Paul were compared with those from control children from these areas. History of radiation exposure was verified from records of hospitals and physicians. There were no striking differences between cases and controls on socioeconomic status, ethnic background, religion, or father's education. Children of mothers who had previously experienced miscarriage or stillbirth had higher leukemia risks. Children whose mothers had experienced irradiation prior to their conception had a relative risk 1.6 times that of other children, and preconception radiation of fathers carried a small excess risk, 1.31, of borderline significance. Children whose mothers were irradiated for diagnostic purposes while they were in utero had a risk about 1.5 times that of children not so irradiated. The risk with radiation was 2.2 for children whose mothers had had a miscarriage. Radiation exposure in the last two trimesters carried the higher risk. Postnatal radiation exposure to more than one site carried a 2-fold risk, and children with mothers exposed to preconception and in utero radiation had a risk about twice that of children of unexposed mothers. Results for intrauterine radiation are consistent with previous studies, and findings regarding postnatal radiation considered in toto are similar to that of some other studies which showed no excess risk. (BBB)

18104 OSTEORADIONECROSIS OF THE JAWS. Francisco, Jose V. (Univ. of the Philippines, Manila). J. Oral Surg., 24: 247-52(May 1966).

Effects of ionizing radiation on oral tissues are reviewed preliminary to a discussion on the cause, prevention, and treatment of osteoradionecrosis. A case report is described in detail to illustrate these features of the disease. For a squamous cell carcinoma, on the floor of the mouth, the patient was treated by radon seed implants (12 seeds in a single elipse plane, 4 by 3.2 cm in dia, total dose 7000 R). Mucositis developed, became worse, then started to regress. At the same time, the malignant lesion disappeared. Two years later the patient complained of an ulcer on the lingual aspect of the alveolus of the left side of the mandible, and a diagnosis of osteoradionecrosis was made. On 4 separate occasions sequestrums either came out spontaneously or were picked out of the mandible. Treatment for osteoradionecrosis was limited to mouthwashes, and the exposed bone was irrigated. The rest of the sequestrum spontaneously separated, leaving the mandible completely covered with mucosa. Extraction of diseased teeth before, and strict oral hygiene practices during, radiotherapy are the best preventive measures. Treatment is relatively ineffective, but surgical and other measures can be employed to reduce pain and control infection. (BBB)

18105 MODIFIED VERTEX VIEW IN BRAIN SCANNING. Holmes, Richard A.; Herron, Charles S.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology, 88: 498-503(Mar. 1967).

Technetium-99m pertechnetate was used to scan the brain from a vertex view. To eliminate salivary secretion of pertechnetate, which was found to produce oral radioactivity obscuring portions of the cerebrum in vertex scanning, atropine was administered parenterally. The structural detail of the vertex view was improved by placing the patient prone and elevating the chin so that the orbitomeatal line was parallel with the detector. In a series of 150 brain scans in which 41 lesions were diagnosed (30 were confirmed), 2 patients had significantly abnormal accumulations of radioactivity seen only on the vertex view. The vertex view was an adjunct in diagnosing abnormal accumulation of radioactivity and provided improved characterization of the lesion. (auth)

18106 EFFECT OF AN ANALOG RATEMETER ON THE MODULATION TRANSFER FUNCTION IN RADIOISOTOPE SCANNING. Gopala Rao, U. V.; Wagner, Henry N. Jr. (Johns Hopkins Medical Institutions, Baltimore). Radiology, 88: 504-8(Mar. 1967).

In many scanning systems, a ratemeter circuit is incorporated to provide a means of contrast enhancement. The concepts of the modulation transfer theory were used to discuss two of the undesirable effects associated with the use of the ratemeter circuit: variations in contrast depending on the size of lesion and spatial displacement. Small lesions tended to have a smaller contrast than larger ones. At the same time large lesions tended to be spatially displaced by larger amounts than smaller lesions. The magnitude of these effects depended on the time constant of the ratemeter circuit and the speed of scanning. It was concluded that these effects were within tolerable limits if the product of these two parameters was less than 0.1. This means that if the time constant is 0.1 second the scanning speed should not exceed 1 in. per second. On the other hand, if the time constant was 1.0 second, the scanning speed used could not exceed 0.1 in. per second. (auth)

18107 EVALUATION OF THE TIME INTERVAL BETWEEN EXTERNAL IRRADIATION AND INTRACAVITARY CURIETHERAPY IN CARCINOMA OF THE UTERINE CERVIX: INFLUENCE ON CURABILITY. Bosch, Antonio; Marcial, Victor A. (Puerto Rico Nuclear Center, San Juan). Radiology, 88: 563-7(Mar. 1967).

Optimal treatment for all stages of carcinoma of the uterine cervix was determined to be external pelvic irradiation followed by intracavitary curietherapy; 297 patients were so treated. While the optimal interval between external irradiation and intracavitary therapy has been considered to be from zero to six days, a delay of seven or more days occurred in the treatment of 98 patients. In a study of five-year survivals independent of stage, no statistically significant difference was found when the interval between modes of therapy was zero to six days versus intervals of seven to fourteen days or of fourteen days or over. An analysis by stage revealed that the incurred delay did not influence prognosis in Stages I and II; in Stage III cases (7 patients) there were no five-year survivors if the delay was more than twenty days. In Stage IV cases (9 patients) there were no five-year survivors if the delay exceeded ten days. It was concluded that a rest period of two weeks between external irradiation and intracavitary therapy was not detrimental to the patient and may be beneficial as it does permit recovery from radiation-induced normal tissue reactions. It was suggested that longer intervals should be avoided in view of the possible harmful influence on curability, particularly in Stages III and IV. (auth)

18108 BETA BACKSCATTER OF DENTAL MATERIALS. Andreas, M. Deut. Stomatol., 15: 198-202(Mar. 1965). (In German).

Backscatter of β particles has been used as a method of measurement in dental industry for many years. The author briefly sketches the general procedures used for measurements of back scattering produced by various dental alloys of different compositions. These measurements were used to analyze the porosity of various plasters and plastics and to determine the thickness of metallic foils used in dentistry. The hardening process of various dental amalgams was studied with these procedures. Volume changes that are known to take place in amalgams that contain different amounts of Ag were ascertained with the backscatter method described. The hardening of dental amalgams containing 50% Ag was studied. The effects of temperature on hardening were similar at various temperatures but varied quantitatively. Since volume changes are indicated by reciprocal changes in density, it was found that they could be determined by β scattering procedures. This method was found to be applicable for studies of deformation, liquation, and recrystallization phenomena. (BBB)

18109 THE PLACE OF RADIOTHERAPY IN THE MANAGEMENT OF PARENCHYMAL CARCINOMA OF THE KIDNEY. Riches, Eric (Middlesex Hospital, London). J. Urol., 95: 313-17(Mar. 1966).

An improved method for treatment of renal cancer that employed preoperative radiotherapy and the changes effected in the tumor by the therapy are described. Effects of preoperative irradiation were as follows: (1) the tumor became smaller, (2) the enlarged veins in the perinephric fat shrank, and (3) an inoperable tumor became operable. The effect of the dose used was mainly on the perinephric tissues and on the peripheral cells of the tumor. The effect on the perinephric tissues were shown by presacral pneumonography. Shrinkage of the engorged perinephric veins occurred; this made the operation easier and allowed the pedicle to be secured at an earlier stage. There was little evidence that the tumor became necrotic because of radiation treatment. The effect of treatment was carcinostatic, not curative. It lessened the risk of dissemination of active tumor cells during the mobilization of the kidney. The dose and the interval between treatment and operation was of critical importance. A dose of 3000 rad given by a supervoltage machine was adequate. A higher dose tended to increase fibrosis around the pedicle and a full dose of 6000 to 7000 rad tended to produce necrosis in the overlying bowel. The optimum interval between treatment and operation was about three weeks; the minimum interval was one week. (BBB)

18110 UREASE IMMUNITY IN NUTRITION, LIVER DISEASE, AND IRRADIATION SICKNESS. Visek, Willard J. (Cornell Univ., Ithaca, N. Y.). N. Y. State J. Med., 66: 2256-60(Oct. 1, 1966).

Experiments with 700 mice showed protection against lethal doses of whole-body ^{60}Co γ irradiation following the induction of active and passive immunity against crystalline jackbean urease. In repeated experiments the median lethal dose at 30 days for untreated animals was 600 R, while for mice injected intraperitoneally with urease antisera it was 860 R. After 800 R, 21% of control animals survived for 30 days, whereas over 70% survived if given immune antisera from rabbits before irradiation. Survival was lower with antisera than with chemical radioprotective agents

such as AET (S,β-aminoethylisothiuronium bromide hydrobromide) and MEA (β-mercaptoethylamine hydrochloride) which must be given immediately before irradiation exposure. It may be significant that both of the chemical agents inhibit urease as parent compounds or metabolites. The immunity approach, however, has the advantage that it is physiologic and may be conferred weeks or months in advance. (BBB)

18111 PREOPERATIVE BIAXIAL ROTARY IRRADIATION OF THE PARAMETRIUM AND LYMPHATIC SYSTEM OF THE FEMALE GENITAL TRACT IN OPERABLE CARCINOMA OF THE CERVIX UTERI. Held, F.; Schwarz, R.; Steinhoff, R. (Univ., Rostock, Ger.). Arch. Geschwulstforsch., 20: 187-209(1963).

A survey of 49,233 patients with various stages of cervical carcinomas treated at 105 different clinics from 1950 to 1954 shows that 16,801 were given radiotherapy alone and 32,432 were given electively surgical and/or radiotherapy treatment. Of these, 22,652 obtained 5-yr cures, which were distributed among 7,949 who were treated radiologically only, and 14,703 who were given the elective surgical and/or radiological treatment. These results show that the total survival rates and the relative 5-yr cure rates of the two groups were not significantly different. Recurrences after clinical healing of the primary tumor can be explained as either spread of carcinoma cells by traumatization of the primary tumor during surgery or radiotherapy or very early metastases to regional lymph nodes. The latter possibility may be related to the fact that up to 80% of all recurrences occur on the pelvic wall. Histological studies indicate that even as early as in stage I and II carcinomas there are up to 45% lymph node metastases on the lateral pelvic wall, even though these are not macroscopically detectable. For this reason radiological treatment should be combined with surgical treatment, even though this may not increase the prospects for 5-yr cures. (50 references.) (BBB)

18112 RADIOTHERAPY AND THE IMMUNOCHEMICAL REACTION TO CANCER. Makidono, Jun (Makidone Radiology Clinic, Hiroshima). Nagasaki Igakkai Zasshi, 38: Suppl., 131-4(Dec. 1963). (In Japanese).

The effect of x irradiation on antibodies was investigated clinically. A 200 to 300 R daily skin dose, over a small field, was given as preoperative irradiation for gastric cancer. Ten to 15 days later at radical operation 5 to 10 g of the excised cancer was subcutaneously transplanted. A month later postoperative irradiation was done if required. To prepare a tumor antigen for use in serologic tests, cancer tissue (1 g in 0.14M normal saline) was homogenized and centrifuged. The supernatant was called solution A; the residue was extracted with pH 7.2 distilled water to prepare a supernatant, called solution B. Both solutions were used as antigens for precipitation and complement-fixation reactions with the irradiated patients' serum. The results were negative with both antigens. The agglutination reaction used was the Boyden tanned-erythrocyte method. An antibody titer of 1:40 to tumor was found in an untreated cervical cancer case with marked necrosis. (BBB)

18113 INFLUENCE OF SINGLE AND FRACTIONATED REPEATED X IRRADIATION (600 R) ON THE COURSE OF RADIATION SICKNESS IN RATS FED A NATURAL AND SYNTHETIC DIET. Nemec, R.; Laginova, V. (Inst. of Oncology, Bratislava). Cesk. Gastroenterol. Vyziva, 19: No. 7, 427-43(1965). (In Czech).

The effects of balanced natural and synthetic diets on the development of radiation sickness were compared in Wistar rats exposed to a single or repeated doses of x irradiation (100 R), the total dose in both groups being 600 R. During chronic irradiation no advantage of either diet was observed. Up to the 50th day there was 100% survival on both diets and no differences were found in various hematologic parameters (hemoglobin, red and white blood cells, including lymphocytes). After a single radiation dose, except for the number of leukocytes, no significant differences between the two diets were found. The number of leukocytes revealed a difference which only partly indicates the advantage of the synthetic diet. The only significant indicator suggesting an advantage of the synthetic diet was survival to the 50th day; only 15% in the group on the natural diet but as high as 45% on the synthetic diet survived the 50-day period. It is concluded that the best results can be obtained by investigating the influence of the dietary regime on the development of radiation sickness under conditions of acute radiation sickness. During chronic radiation sickness a temporary adaptation of the animal is possible and the influence of the dietary pattern thus cannot be demonstrated. It is recommended that similar investigations should be made using only a single dose of irradiation. (BBB)

Radiation Effects on Animals

Refer also to abstracts 17951, 17995, 18006, 18023, 18033, 18046, 18066, 18074, 18084, 18087, and 18088.

18114 (BNL-10988) MODIFICATION OF SKIN ALLOGRAFT IMMUNITY BY EXTRACORPOREAL IRRADIATION OF LYMPH. Joel, D. D.; Chanana, A. D.; Cronkite, E. P.; Schiffer, L. M. (Brookhaven National Lab., Upton, N. Y.). Jan. 11, 1967. Contract AT(30-2)-Gen-16. 14p. (CONF-670112-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Transplantation Conference, Santa Barbara, Calif.

Thoracic duct lymphocytes of calves were continuously destroyed by extracorporeal γ irradiation of the lymph (ECIL) for up to 68 days. Skin grafts which were placed within the drainage bed of the thoracic duct (posterior grafts) were compared to grafts from a second donor which were not drained exclusively by the thoracic duct (anterior grafts). Pregraft ECIL for 10 to 22 days produced lymphopenia and prolonged survival of anterior and posterior grafts for 8-10 days. When ECIL was continued after grafting, anterior grafts were rejected as before, but posterior grafts remained intact until ECIL was discontinued. Postgraft ECIL delayed and markedly suppressed the cytotoxic antibody activity in the serum although small amounts could be detected while grafts were intact. Following the termination of ECIL, the cytotoxic activity increased, however, at the time of rejection it was still well below that found in untreated calves. (auth)

18115 (COO-1244-8) ANATOMY OF THE INTESTINE: FINE STRUCTURE OF THE INTESTINAL EPITHELIUM AFTER 3 krads OF X-RAYS. Hampton, James C. (Northwestern Univ., Chicago, Ill. Dept. of Anatomy). Sept. 26, 1966. Contract AT(11-1)-1244. 30p. (CONF-660917-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Gastrointestinal Radiation Injury Symposium, Richland, Wash.

Electron microscopic studies on the ilea of mice exposed to 3 krads of x radiation showed that ribosome depletion, mitochondrial damage, and reduction of absorptive capacity are characteristic features of epithelial cells remaining on the villi and in the crypts at 3 to 5 days post-irradiation. Some evidence, although inconclusive, was presented that the epithelial basement membrane was also damaged. It was suggested that, at the dose used, damage was probably not limited to proliferating cells but that post-mitotic differentiating cells were also affected. (auth)

18116 (NYO-2356-22) STUDIES OF THE EFFECTS OF ULTRAVIOLET RADIATION ON CELL STRUCTURE AND BEHAVIOR. Annual Progress Report, December 1965-December 1966. Freed, Jerome J. (Institute for Cancer Research, Philadelphia, Pa.). Dec. 30, 1966. Contract AT(30-1)-2356. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

During the past year, the working hypothesis that saltatory movements of intracellular particles are mediated by cytoplasmic microtubules was further tested. Electron micrographic reconstructions of the paths of individual microtubules through the cell agree with the pattern of particle trajectories observed in time-lapse experiments. Pinocytosis and phagocytosis, processes in which saltatory movements are observed, were found to be partially inhibited by colchicine, which destroys the microtubules of interphase cells. The vibrating mirror flying spot microscope was modified by addition of an automatic specimen-shifting mechanism to make possible recording of detailed uv-absorbance spectra of living cells. The spectra obtained show greater freedom from effects of scattered light than those obtained from fixed tissue. Related studies supported in part by this contract are summarized. These include the development of culture techniques for the genetic study of haploid frog cells, and experiments on the effects on cells of icrin, an inhibitory macromolecule from adult liver. (auth)

18117 (NYO-3355-18) EFFECT OF IONIZING RADIATION ON DEVELOPMENT OF EMBRYONIC MOUSE ORGANS. Comprehensive Report of Activities for the Period May 1, 1964-April 30, 1967. [Borghese, Elio] (Naples Univ. (Italy). Istituto di Anatomia Topografica). Contract AT(30-1)-3355. 6p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Radiation effects on growth inhibition of the embryonic lung were investigated. A method for measuring pulmonary organogenesis was developed. It was found that pulmonary epithelium is unable to undergo morphogenesis in the absence of mesenchyme. Mesenchyme is the organizer of the epithelial tree and is also effective in regulating the growth rate of epithelium. In vitro studies were conducted on the early stages of development of embryonic lungs. Studies on salivary glands included histochemical studies and in vitro experiments on radiation effects on secretory activity. The development of the elasmobranch kidney was investigated using embryos and newly hatched specimens. Ossification processes in bones of embryonic mice were studied. Reaggregation of tissue cells in vitro was studied using epithelium and mesenchyme. (H.L.W.)

18118 (SZS-11(1966)) VERAENDERUNGEN DER BIOELEKTRISCHEN AKTIVITAET DES GEHIRNS DURCH EINWIRKUNG IONISIERENDER STRAHLUNG. (Changes in the Bioelectric Activity of the Brain by the Action of Ionizing Radiation). Michel, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Sept. 1966. 38p. (In German). Dep. mn.

Experimental and clinical studies of radiation effects on brain electrical activity so far known in literature are surveyed and discussed with regard to evidence of radiosensibility of the brain and the usefulness of the surface EEG as a criterion for radiation-induced functional changes or damages to the CNS. The results demonstrate that even smallest radiation doses may cause transitory functional changes in the brain and that various structures of the brain obviously have a high selective radiosensibility. The difficulties in interpreting the changes of brain electrical activity caused by small and medium radiation doses are pointed out, especially with regard to the question when these changes must be considered a damage. The question, whether the surface-EEG is useful as a criterion for changes or early damages of the function of the brain caused by small and medium radiation doses cannot be answered by investigations to date with mainly conventional, qualitative EEG-analysis and its final clearing is reserved for further studies with objective, quantitative (automatic) analysis. (auth)

18119 (SZS-12(1966)) ABNORMAL MOLECULES IN URINE AFTER IRRADIATION. Dienstbier, Z.; Arient, M.; Shejbal, J. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). Oct. 1966. 29p. Dep. mn.

In a review of different catabolites, the excretion of which is quantitatively changed after irradiation, their importance for the diagnosis of postirradiation damage is discussed. There are 216 references. (auth)

18120 (USNRDL-TR-67-18) STUDIES ON GASTRIC RADIATION INJURY: DIFFERENTIAL EFFECTS ON ACID SECRETION AND BIOELECTRICAL ACTIVITY. Vaughan, B. E.; Cummins, J. T.; Ridley, H. A. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 7, 1967. 25p.

Female rats, 6 months old were used during the experiments. In isolated preparations, mucosal acid was secreted with counterpart serosal base independently of electrogenic activity. X irradiation had no effect directly on the electrogenic mechanism between 135 RAD and 11 Krad, although abscopal effects showing dose dependence and RBE changes had been previously established 7 days after 560 RAD. In the otherwise intact animals acid secretion was not inhibited immediately after doses of approximately 900 RAD. In the animal, also, bioelectric inhibition depended on intact vagal innervation, as did the tonic maintenance of high rates of acid secretion. Autonomic control factors seemed to dominate any primary irradiation effect, and possible direct radiation injury appeared to be offset by subcellular repair processes. (auth)

18121 (USNRDL-TR-67-19) LIVER FUNCTION AND REGENERATION IN RATS X IRRADIATED AT BIRTH. Leong, G. F.; Pessotti, R. L.; Krebs, J. S.; Albright, M. L. (Naval Radiological Defense Lab., San Francisco, Calif.). Feb. 8, 1967. 28p.

In the present investigation, animals subjected to x irradiation (200 rad) at one day of age have been studied 90 days later with respect to incidence of mitotic abnormalities in parenchymal cells after partial hepatectomy and to the functional competence of the liver. X irradiation of neonatal rats results in a similar decrease in both liver and body weights of animals 90 days later. Thus, liver to body weight ratios for both irradiated and non-irradiated controls are the same. The regenerative capacity of the irradiated animals, i.e., the ability to replace hepatic mass as a result of partial hepatectomy, does not appear to be impaired. The incidence of abnormal mitoses (~45% of total anaphases and telophases) is approximately 3 to 4 times greater than that of controls. In contrast, bile flow and BSP excretion rate are not affected in animals irradiated at one day of age. Therefore, the functional tests of bile flow and BSP excretion do not reflect the extensive nuclear damage present in parenchymal cells. (auth)

18122 (USNRDL-TR-1053) INJURY ACCUMULATION AND RECOVERY IN SHEEP EXPOSED TO PROTRACTED ^{60}Co GAMMA RADIATION. Hanks, G. E.; Ainsworth, E. J.; Leong, G. F.; Nachtwey, D. S.; Page, N. P. (Naval Radiological Defense Lab., San Francisco, Calif.). July 29, 1966. 28p. CFSTI $3.00 cy, $0.65 mn.

A modified split-dose technique has been used to measure the accumulation of injury during protracted exposures of the domestic sheep to Cobalt-60 gamma radiation. An initial or conditioning exposure of 165 R was given at 0.5, 0.95, 1.85, and 3.94 R/hr, and the acute exposure $LD_{50/60}$ was determined thereafter. These studies indicate that there is a dose rate threshold for injury accumulation under these conditions of protracted irradiation and that the threshold lies between 1.0 and 1.5 R/hr. Recovery from injury accumulated during protracted exposures has been studied by determining the $LD_{50/60}$ at various times after protracted exposures. These studies indicate a rapid recovery without a lag period that proceeds to a transient acquired radioresistance 15 days after the conclusion of the protracted irradiation. (auth)

18123 STUDIES ON SHORT-TERM RECOVERY PROCESSES IN THE STIMULATION THRESHOLD OF PERIPHERAL NERVE FIBRES ALTERED BY X-IRRADIATION. Vanselow, K. (Univ., Kiel). Atompraxis, 13: 34-7(Jan. 1967). (In German).

An apparatus for registering the changes in the electrical stimulation threshold of the sciatic nerve of Rana temporaria caused by irradiation with soft x rays is described. A peak rectifier is used for electrical processing of the action potential. Registration is made continuously, so that short-term changes can also be detected. Experimental study was made of the recovery process from radiation-caused changes in stimulation-threshold tension. After short-term irradiation, a time-dependence was found experimentally. The half-life value is approximately 1 minute. (auth)

18124 THE RADIOSENSITIVITY OF DROSOPHILA SPERMATOGONIA. I. ACUTE DOSES. Oftedal, Per (Norwegian Radium Hospital, Montebello). Genetics, 49: 181-93(Feb. 1964).

The frequency of sex-linked recessive lethals in Drosophila melanogaster was measured after irradiation of spermatogonia with 55, 110, 160, and 300 R doses of 180-keV x rays. A nonlinear dose-effect relation was found, with maximum effect of 0.14% lethals at 160 R, and practically no effect at 300 R. Differential killing in conjunction with sensitivity variations is invoked to explain the results. In terms of the hypothesized heterogeneity among spermatogonia, a model for the analysis of the radiogenetic effects observed was formulated. Its main feature is that the observed genetic effect is determined by the effect induced in the surviving sensitive cells relative to the total cell population sampled. With high doses, effects induced in the surviving, resistant part of the cell population would be observed, and a linear dose-effect curve found, since the surviving cell population should be homogeneously resistant to killing. Presumably it is also less sensitive to mutation induction. At very low doses, effects induced in the sensitive cells would dominate, and these cells should also survive, leading to a linear dose-effect curve of steeper slope in this low range. In the intermediate range, where some killing of sensitive cells takes place, selective killing would then lead to a nonlinear dose-effect curve in the transition between the two slopes, from the higher to the lower. (BBB)

18125 BIOCHEMICAL CHANGES IN MICROWAVE CATARACTS. Kinoshita, J. H.; Merola, L. O.; Dikmak, E.; Carpenter, R. L. (Harvard Medical School, Boston. Massachusetts Eye and Ear Infirmary, Boston. Tufts Univ., Medford, Mass.). Doc. Ophthalmol., 20: 91-103(1966).

The eyes of rabbits were exposed to microwave radiation at a frequency of 2450 mc, wavelength of 12.3 cm and at a power density of 280 mw/cm^2. The first change that occurred in the lens of the eye appeared to be a decrease in the level of ascorbic acid; the depression did not occur immediately, but was observed 6 to 18 hours postirradiation. The loss in ascorbic acid was therefore not considered to be a thermal effect. There was no corresponding change in the ascorbate level of the aqueous humor. At a later postirradiation stage, when opacities first became visible, electrolyte and osmotic changes were also apparent. The degree of opacification of the lens seemed to parallel the increase in electrolytes and water. Results suggested that lens permeability was increased by microwave irradiation. (B.H.S.)

18126 MICROCIRCULATION OF TUMORS. PART II. THE SUPERVASCULARIZED STATE OF IRRADIATED REGRESSING TUMORS. Rubin, Philip; Casarett, George (Univ. of Rochester, N. Y.). Clin. Radiol., 17: 346-55(Oct. 1966).

A phenomenon of supervascularization in irradiated regressing tumors was demonstrated by the use of correlative microangiographic and histologic techniques in transplanted rat tumors. This supervascularization effect was more consistently seen with tumor regression after fractionated dose schedules. After large single doses, the vasculature of both tumors and normal tissues tended to be fragmented despite tumor regression. It was essential to preserve present fractionation schemes in the radiotherapy scheme used since, as a result of regression and supervascularization, there may often be better oxygenated cell populations available for each subsequent fractional dose of radiation. A clinical trial using atmospheric oxygen breathing by mask, so that present fractionation dose schedules may be more easily preserved, was proposed. (auth)

18127 RADIOSENSITIVITY OF DRUG-RESISTANT L1210 LEUKEMIA. Johnson, Ralph E. (National Cancer Inst., Bethesda, Md.). Cancer Res., 27: 251-4(Feb. 1967).

The x radiation response of murine L1210 leukemia was examined. Radiation dose-survival curves demonstrated that nondividing (resting) leukemia cells and logarithmically proliferating leukemic cells were equally radiosensitive. A radiosensitive state was also demonstrated for 2 drug-altered leukemia cell lines, 1 strain being markedly resistant to antimetabolite therapy and the other having a decreased growth rate following exposure to an alkylating agent. These studies indicate that cross-resistance does not exist in this experimental system under conditions where drug resistance is present. (auth)

18128 RESTORATION OF IMMUNOLOGIC REACTIVITY OF THYMECTOMIZED MICE BY CALF THYMUS EXTRACTS. Trainin, Nathan; Linker-Israeli, Mariana (Weizmann Inst. of Science, Rehovoth, Israel). Cancer Res., 27: 309-13(Feb. 1967).

Various calf organ extracts were injected into newborn thymectomized mice, and into adult thymectomized and irradiated mice, of C57BL/6 and C3H/eb strains. Whereas mice receiving either calf muscle or calf kidney extracts manifested an impaired immunologic response, of the same magnitude as equivalent controls, animals injected with calf thymus extracts resembled intact normal mice in their immunologic behavior. The immunologic repair, produced by thymus extracts, appears therefore to be specific to this organ, and to involve a hormone-like mechanism. Evidence for the contribution of this calf thymus factor to the restoration of immune competence in spleen cells of thymectomized mice is presented. The precise mechanism of this apparent hormone-cell interaction is still unknown. (auth)

18129 HOMOGRAFT REJECTION BY NEONATALLY THYMECTOMIZED GERM-FREE MICE. Bealmear, Patricia M.; Wilson, Raphael (Univ. of Notre Dame, Ind.). Cancer Res., 27: 358-61(Feb. 1967).

A response to tissue transplantation was elicited in germ-free neonatally thymectomized CFW and C3H mice by challenge with homotransplantations of methylcholanthrene-induced tumor cells and neoplastic lymph node cells. Germ-free thymectomized mice of both CFW and C3H strains accepted all isologous transplants and rejected all homologous transplants with only 1 exception. When these thymectomized mice were irradiated, their immune response seemed to be effectively depressed and homologous transplants made 3 days after irradiation were accepted by both strains. In CFW thymectomized and irradiated mice the tumor enlarged and eventually killed the mouse, but in C3H thymectomized and irradiated mice the tumor did not enlarge, but persisted until 6 weeks, when the experiment was terminated and the animals were sacrificed and autopsied. However, when transplantation of C3H tumors to CFW mice was delayed until 2 months after irradiation to permit recovery of immunologically active tissues, most of the tumors were rejected after a brief period of acceptance. Results of transplantation of neoplastic lymph node cells from C3H mice infected with leukemia were comparable to those from the tumor transplants. Both germ-free and germ-free thymectomized CFW mice were able to reject homologous lymph node cells from C3H mice; all but 1 of the C3H control mice developed leukemia. Neonatal thymectomy alone does not deprive CFW and C3H mice of the ability to reject tumor homotransplants, nor does exposure to 300 R of x-radiation abolish this response in these thymectomized mice. The assault by microorganisms on the conventional mouse at a time when it has been deprived of most of its lymphoid tissue appears to overtax its immunologic defense and to induce a debilitated state in which it cannot successfully respond to a homotransplant. (auth)

18130 RADIOAUTOGRAPHIC STUDIES OF THE EFFECT OF X RAYS ON THE ASCITES LYMPHOID LEUKEMIA CELLS IN MICE. Aleshchenko, A. V.; Lipchina, L. P.; Frankfurt, O. S. (Inst. of Chemical Physics, Moscow). Tsitologiya, 9: 217-22(Feb. 1967). (In Russian).

In the ascite lymphoid leukemia cells the generation time was found to be 20 hours, the duration of phase S was 12.75 hrs, of phase G_2—4 hrs, of phase G_1—2.75 hrs, of mitosis—35 minutes. The proliferation pool was shown to be 0.88. The division intensity was identical for tumor cells of type A (65% of population) and type B (35%). X-ray treatment induced blocking of the cell transition from phase G_2 to mitosis, a 50 per cent decrease in DNA synthesis and an inhibition of cell division in 120 hrs. after irradiation. The effect of increasing doses of irradiation on DNA synthesis has revealed that S_0 and S_1 effects, characteristic of normal lymphoid cells, are exerted in the ascites leukemic cells as well. (auth)

18131 EFFECTS ON DOGS OF CHRONIC EXPOSURE TO MICROWAVE RADIATION. Deichmann, William B.; Bernal, Ernesto; Stephens, Frank; Landeen, Karin (Univ. of Miami, Fla.). J. Occup. Med., 5: 418-25(Sept. 1963).

Two female beagle dogs were exposed to microwave radiation of 24,000 Mcps at a power density of 20 mw/cm^2. Over 20 months Dog D-135 was exposed for a total of 2631 hr (6.7 hr/day on 5 days of the week). Dog D-138 was exposed for a total of 3970 hr (16.5 hr/day on 4 days of the week). Neither dog showed signs of radiation effects. Rectal temperatures, blood volume, hematocrit, hemoglobin, erythrocytes, total and differential leukocytes, blood cholesterol, and protein-bound iodine values showed no significant changes from normal. No eye abnormalities were produced. Both dogs reproduced normally. One animal had a litter of 5 (one stillborn) after 1500 hr of exposure; the other dog had 2 litters of 5 puppies (2 stillborn) after 200 hr of exposure, and 4 puppies (one stillborn) after 1850 hr of exposure. Gain in body weight was subnormal in both animals. Dog D-135 gained 0.3 kg and Dog D-138 lost 1.2 kg over the 20-month period. Dog D-135, exposed 6.7 hr/day, lost a mean of 21.5 g/hr of exposure; Dog D-138, exposed 16.5 hr/day, lost a mean of 23.1 g/hr of exposure. By taking into consideration the weight of excreted urine and feces (during exposure), Dog D-135 lost a mean of 3.5 g during an hr of exposure, while Dog D-138 lost a mean of 1.8 g/hr. (BBB)

18132 IMPACT OF THE LASER ON NEVI AND MELANOMAS. Goldman, Leon; Igelman, Jon M.; Richfield, Daniel F. (Children's Hospital Research Foundation, Cincinnati). Arch. Dermatol., 90: 71-5(July 1964).

Changes in pigmented nevi and in melanoma were produced in experiments with low energy lasers (0.5—1.0 J of exit energy from the laser head), as well as with high energy lasers (25 to 125 J) which produced a more extensive change. The cellular nevi exposed to the laser included 2 junctional, 7 mixed, and 3 dermocellular types. Except with a focused beam of high energy lasers, the major effect was superficial coagulation necrosis. In small junctional nevi, however, destruction was relatively deep and complete. The striking feature which distinguished this type of energy from that of electrocoagulation or heat cauterization was the sharp demarcation of tissue destruction with the laser. Also noted was the relative resistance of the hair follicle to changes induced by the laser beam. Unlike tissue necrosis from heat, necrosis from the laser spread for some time after impact. With the unfocused 0.5-J beam, pigmented melanoma cells showed destructive changes whereas white cells and fibroblasts showed no changes. Red cells absorbed considerable laser energy and showed changes. The focused beam of the ruby laser produced deep necrotic zones, and when the neodymium laser's energy output was high, deep destructive changes were produced. When the output was 10 J or less, only superficial changes were observed. A thermal effect was seen, with selective absorption of the incident energy in pigmented tissues, melanin, hemoglobin, and tattoo pigments. Experimental irradiation of methylcholanthrene tumors showed only superficial changes of the papillomatous and hyperkeratotic masses. This seemed to indicate some protective action from thick keratin. (BBB)

18133 LATE EFFECTS OF WHOLE-BODY IRRADIATION. Duplan, J. F. (Laboratoire Pasteur, Paris). Rev. Franc. Etud. Clin. Biol., 11: 659-63(Aug.-Sept. 1966). (In French).

An editorial on how late effects of whole-body exposure to ionizing radiation are consequences of a series of events that take place at the level of cells, organs, or tissues is presented. The events that take place at each of these levels are described and discussed. Explanations for residual injuries that can be found at the whole organism level are offered. Hypotheses that have been proposed to explain the accelerated process of ageing are also considered. The possible mechanisms of radioinduction of tumors in relation to direct or indirect induction of mutations in stem cells are briefly discussed. (B.H.S.)

18134 TREATMENT OF THYROTOXICOSIS WITH RADIO-IODINE-131. CLINICAL AND RADIOLOGICAL RESULTS IN 1344 PATIENTS. Schneider, Claus (Univ., Hamburg). Strahlentherapie, 127: 65-86(May 1965). (In German).

Past treatment results in 1344 patients of whom 1016 were treated with a single dose of ^{131}I. The patients were examined regularly for 13 yr after treatment. In 6.9% of the patients rheumatoid symptoms appeared 1 to 9 months after treatment. In a few patients there appeared an endocrine ophthalmopathy, without malignant decompensation. Myxedema, localized in the lower leg, appeared in 4 cases. In 11 patients a psychotic syndrome was evident 4 to 8 weeks after treatment. In 8 cases there was exacerbation of thyroid hyperfunction. Recurrence of hyperfunction was observed in 5 cases. Hypothyroidism appeared in 83 patients. During the first yr there was 2.5% incidence, and there was 0.6, 1.2, and 5.0% in the second, fifth, and thirteenth yr. The frequency of an early appearance of hypothyroidism depended on the size of the ^{131}I dose, the size of the thyroid gland, and the relative radio-

resistance of the gland. Smaller size glands became hypofunctional more readily than larger glands. After 13 yr the cumulative hypothyroid frequency was 27%. The thyroid structure (whether dif fuse or nodular), recurrence after operations, and combination with endocrine ophthalmopathy had no correlation with the frequency of appearance of hypothyroidism. References cited, 54. (BBB)

18135 SOME CONSIDERATIONS OF MICROWAVE HAZARDS EXPOSURE CRITERIA. Palmisano, William A.; Peczenik, Alois (Fort Sam Houston, Tex.). Mil. Med., 131: 611-18(July 1966).

Biological effects of microwave radiation in relation to radiation injuries that can be received by personnel operating radar equipment, and those resulting from x rays generated by the apparatus are discussed. The most important biological effects of microwave radiation that are considered were whole-body heating, damage to the lens of the eye (cataracts), and testicular damage. In man, radioinduced sterility or infertility has not been reported as being associated with working with microwave radiation. The known and suspected cases of cataract that have been reported were few. Every reported case of cataracts had occurred from exposures exceeding the permissible level for continuous exposure by a factor of at least 10, but more probably by a factor of 100. No potential personnel health hazard could be attributed to x rays produced by microwave systems as long as the manufacturer's protective shielding remained intact. In one instance, in which maintenance personnel removed the protective shielding for repair work, doses of x radiation sufficient to cause erythema and changes in the blood picture were received. It was emphasized that wave guide systems, radar, and diathermy are remarkably safe provided that they are used in accordance with recommended safety standards. (TSS)

18136 CURRENT STATUS OF LASER COAGULATION. Chisholm, I. A. (Western Infirmary, Glasgow). Scot. Med. J., 11: 101-6(Mar. 1966).

A review of the literature on biological effects of laser radiation on tissues of the eye is presented. Factors controlling the amount of damage from laser radiation, reactions of eye tissues to laser radiation, and laser radiation injuries in the eye are discussed and described. The author concluded that the principal effect of laser radiation on the eye seemed to be thermal. Experiments to determine the effects of laser radiation on eye tissues of birds were conducted in order that the function of pecten, a vascular pigmented structure that is peculiar to the eyes of birds, could be elucidated. Pectens were treated with laser radiation and photocoagulation atrophy was produced. Initial experiments on eyes of dead birds revealed areas of localized tissue damage with crater formation; these were noted as being similar to lesions that appeared on laser irradiated hamster skin. Irradiation of pectens in living birds produced a mixed picture of atrophy and excessive proliferation of fibroblastic tissues that mushroomed out from the bridge of the pecten. The proliferation of the fibroblastic tissues was considered to be a repair mechanism. (TSS)

18137 HISTOPATHOLOGY OF LASER-PRODUCED LESIONS IN CAT BRAINS. Liss, Leopold; Roppel, Richard (Ohio State Univ., Columbus). Neurology, 16: 783-90(Aug. 1966).

The effect of direct laser radiation on the mammalian brain was studied using pulses of radiation generated by a ruby laser. The depth of penetration of the photon beam into cerebral structures, the path of the beam through the tissue, and the nature of tissue and cell changes were determined by histopathological and histochemical studies. Energies of 0.1 to 10 J were used. Results on cat brains showed superficial destruction as well as deep penetration with the Q-switched pulse, while in the normal mode, radiation doses up to 10 J of pulse energy produced no destructive changes. Results from the third day post irradiation suggested a specificity of laser-produced lesion with a mechanism which spared the deep white matter and produced a periventricular lesion. The evidence of marked astroglial response, even after irradiation with normal mode, indicated the possibility of severe tissue alterations after a long survival period. The differential vulnerability of the cortex and the white matter to laser beam irradiation was also seen; even in the most severely damaged brains irradiated with a Q-switched, 1-J energy pulse where laceration of marginal cortex was achieved, the deep cortical areas showed little or no alteration, while evidence of degeneration reappeared in the subcortical white matter. Techniques for enzyme histochemistry demonstrated cellular alterations in areas where other histological methods revealed no change. (TSS)

18138 PRECANCER OF SKIN. I. DIAGNOSIS AND TREATMENT. Davis, Jeff (Pack Medical Group, New York). N. Y. State J. Med., 66: 2923-35(Nov. 15, 1966).

Various types of cancer induced by uv and ionizing irradiation of skin are described, as well as their detection and therapy. Late sequelae in the skin of various origins, for example, scars resulting from trauma, chemical, or physical agents, may develop carcinomatous change many years after their inception. Farmers and others excessively exposed to uv light are prone to have precancerous keratoses. If untreated, 12 to 25% of these cases become skin cancers. Other actinic exposure, such as that from x ray, Ra, or radioisotopes, may produce cancer of the skin either from therapeutic doses or as a result of adventitial over-exposure incurred as an occupational risk. After 10 to 15 yr exposure to the actinic rays, general skin changes take place in the exposed areas similar to those found in chronic x-ray dermatitis and xeroderma. Almost 100% of the uv spectrum having wavelengths between 2500 and 3500 Å is absorbed in the epidermis, and only this portion of the uv spectrum of the sun's rays is carcinogenic. Stimulation of the cancerous process appears to depend on the total amount of radiation exposure per day without regard to the intensity or duration of each exposure. The best treatment for keratoses which arise is early removal. Radium and x-ray therapy are not indicated because their late effects closely simulate those effects from which the keratotic changes had their inception. As a result of chronic excessive trauma produced by local irritants, repeated uv or x radiation therapy, and scratching, leukoplakia may ensue. Carcinoma may subsequently develop as a secondary complication. (BBB)

18139 ON SOME QUALITATIVE MODIFICATIONS OF SALIVA (VISCOSITY, MUCINOLYTIC ENZYMES) AFTER RADIUM THERAPY. Tomasetti, L.; Ricci, T.; Nannelli, M. (Univ., Florence). Boll. Mal. Orecchio., Gola, Naso, 83: 91-104(Jan.–Feb. 1965). (In Italian).

Studies were conducted in 30 patients submitted to total laryngectomy and Ra therapy. A 105-mg Ra source was used to give a dose of 6500 R to the cervical lymph nodes. The calculated dose to the submaxillary gland was 3400 R, to the sublingual gland 2800 R, and to the parotid gland 2400 R. Laryngectomy did not affect viscosity of saliva from these glands. In most irradiated patients the viscosity of parotid saliva increased, as measured one to two months after irradiation. It then returned to normal ~4 months after treatment was concluded. A contrasting effect was noted in submandibular saliva, its viscosity decreasing one to two months postirradiation. Also, total saliva, which before treatment had a viscosity higher than that of the submandibular gland, showed decreased viscosity after irradiation. In some cases at the termination of Ra therapy it was not possible to stimulate salivation by pilocarpine treatment. Postirradiation saliva stimulated by pilocarpine often contained desquamated epithelial cells. In most cases the changes in salivary gland secretions were transitory but in a few cases receiving high dosage irradiation they were permanent. (BBB)

18140 IRRADIATION OF CELLULAR ORGANELLES WITH THE AID OF A RUBY LASER. Bessis, Marcel; Gires, Francois; Mayer, Guy; Nomarski, Georges (Laboratoire C S F, Corbeville, France). Compt. Rend. Acad. Sci., 255: 1010-12 (July 30, 1962). (In French).

The effect of a ruby laser beam (wavelength 6942 Å) operated through a microscope on blood cells and mitochondria is described. A beam of 5-mm dia was produced at a 1-m distance. The magnification of the eye piece used reduced the dia of the beam by $\frac{2}{3}$, which was calculated at ~2.5 μ. At the moment of irradiation a round spot the same dia as the beam became visible on human red blood cells, followed immediately by hemolysis. Cells became progressively discolored in the region surrounding the spot where hemoglobin appeared to be coagulated. In some cases hemolysis was immediate and only stroma could be seen. A less pronounced effect was observed with white blood cells and other cultured cells. Such injury to red blood cells was not expected since their absorption at this wavelength is negligible. A more intense effect was observed when cells were stained with Janus green. When mitochondria were stained with a weak Janus green stain, they could be selectively destroyed. (BBB)

18141 ANALYSIS OF THE HEAD-NECK REGION OF TACHYCINES (SALTATORIA) BY MORPHOLOGICAL UNITS. II. EXPERIMENTAL-TERATOLOGICAL FINDINGS IN THE CRANIAL SKELETON WITH REFERENCE TO THE CENTRAL NERVOUS SYSTEM. Wada, Shoji (Univ., Wuerzburg, Ger.). Zool. Jahrb., Abt. Anat. Ontog. Tiere, 83: 235-326(1966). (In German).

Numerous examples of unilateral and bilateral defects, and double and triple multiplication in the cephalothorax and thoracic regions of Tachycines asynamorus were observed after uv irradiation or modifications in ovo. The eggs were irradiated 6 or 8 at a time in a chamber. It was possible to produce defects by irradiation for 5 min, using a Leitz uv lamp with an S100 bulb and a UG5 filter. The most practical irradiation time ranged from 3 to 15 min. The author presents numerous diagrams and photographs to illustrate the defects produced by the uv irradiations. These included defects in the frontal and eye regions; antennae; postocular, cheek, and occipital regions, and the oral region. Morphological patterns developed from the study are discussed

at length for the cranial components, postocciput, tentorium, cranial suture, clypeolabrums, segmental components of the hypopharynx, the submentum, and the structure of the thorax. References cited, 91. (BBB)

18142 ENVIRONMENTAL RADIOACTIVITY AND ITS BIOLOGICAL SIGNIFICANCE. Mayneord, M. V. (Univ. of London). Sci. Basis Med.: Annu. Rev., 16-37(1966).

The origins of natural radiation, its distribution, and its variation from place to place, and particularly its possible significance in biology and medicine, are reviewed. Uranium-238 and ^{232}Th seem to be the parents of most of the natural terrestrial radioactivity. Their daughters (including Ra) form the bulk of the radioactive material to be found in igneous, metamorphic, and sedimentary rocks. The sole exception of importance is ^{40}K, an isotope of wide occurrence, and possibly the most important radioactive material in the biosphere and a main constituent of the lithosphere. An analysis is made of incidence of various diseases, which may arise from radiation exposure, in terms of background levels of radioactivity. A survey of the mortality from congenital malformations in different geological regions of the United States has suggested that higher incidences are associated with geographical areas that contain major U ore deposits, uraniferous waters, or He concentrates. Another survey suggested correlation of congenital malformations with geomagnetic latitude and hence cosmic rays, but results of these surveys are not convincing. There is no certain evidence that natural radiation influences the cancer rate in man, and this is not surprising since its intensity is rarely 1% of the lowest dose-rate so far shown to induce malignant disease in man or animals. In Great Britain, one of the few investigations carried out in this field consisted of investigations of radioactivity of food and water and the corresponding variations of daily intake of ^{226}Ra for correlation between the incidence of cancer and the radioactivity of drinking water. The data did not provide evidence of any association between cancer mortality rates (i.e., carcinoma of the breast, uterus, trachea, lung, bronchus, stomach, or leukemia) and the natural radioactivity of the drinking water. Indeed, the areas of Wales which show surplus mortality for gastric cancer were associated with drinking waters with low activity. A similar negative correlation is suggested for primary bone tumors. In spite of large numbers of observations there is, as yet, no direct evidence that the geography of life and death has any correlation with natural radiation background. The intricacies of the radiation pattern, together with the complexity of the shifting social picture make the certain demonstration of effect at natural levels of irradiation extremely difficult. (BBB)

18143 MATHEMATICAL TREATMENT OF THE SURVIVAL CURVES OF MICE AFTER SINGLE SHORT-DURATION WHOLE-BODY IRRADIATION. Heuss, K. (Max-Planck-Institut fuer Biophysik, Frankfurt am Main). Biophysik, 3: 232-40(1966). (In German).

A formula is given which describes the relation of dose vs mean survival time after single whole-body irradiation of mice (Rajewsky). The formula is derived from a model explaining the death of the animal as result of the radiation reaction of three different cellular systems. The formula gives account too for the results of continuous irradiations of mice with dose rates between 0.46 and 805 kR/day (Rajewsky et al.). (auth)

18144 EFFECT OF GAMMA RADIATION ON TROGODERMA GLABRUM AND ATTAGENUS PICEUS. Tilton, Elvin W. (Stored-Product Insects Research and Development Lab., Savannah, Ga.); Burkholder, Wendell E.; Cogburn, Robert R. J. Econ. Entomol., 59: 944-8(Aug. 1966).

The effects of ^{60}Co γ radiation on stored-grain beetles were examined preliminary to the development of techniques for a commercial eradication program. All metamorphic stages of the insects were treated with 13.2, 17.5, 25, 45, and 100 krad or with 13.2 krad repeated 5 times at hourly intervals for a total of 66 krad. Radiation effects on life-span, developmental progress, and reproduction of the irradiated insects were checked at intervals of one week. Eggs and larvae of both species were controlled effectively by all doses. However, the production of immediate and complete mortality of any of the stages of either species was not achieved with any of the radiation doses used. Propagation in both species was limited to F_1 generation in insects of the P_1 generation that received the lowest radiation dose. Genetic damage that was transmitted to the F_1 generation resulted in a greater incidence of sterility in F_1 individuals and in a reduction of progeny from nonsterilized F_1 individuals. Although male adults and pupae of both species were more resistant than females to radiation, the trend did not always follow the same pattern in the F_1 generation. F_1 progeny from P_1 irradiated male T. glabrum were more susceptible to inherited radiation damage since a higher rate of radioinduced sterility was observed. The reverse was true for T. glabrum pupae. The life-span of both species of beetles that were treated in the adult stage was prolonged by all radiation treatments except 100 krad. (BBB)

18145 LASER IRRADIATION OF BIOLOGICAL SYSTEMS. Fine, S. (Northeastern Univ., Boston); Klein, E.; Scott, R. E. IEEE (Inst. Elec. Electron. Eng.) Spectrum, 1: 81-95(Apr. 1964).

Exploration of laser devices for application to biology, including microscopy and microsurgery, is discussed, and studies on biological effects of lasers and their implications are reviewed. The use of fiber optics systems for transmission of laser radiation for diagnosis and treatment of deep-seated pathological tissues, as well as for cauterization and specialized surgical procedures and the hazards involved are also pointed out. Investigations described include studies on effects of laser radiation on macromolecular preparations, single cells, eyes, skin, and tumors of animals, production of free radicals, and application of laser spectroscopy to biological systems. A discussion on the major potential clinical application of lasers for production of retinal coagulation is presented. A discussion on basic investigations that should be made and speculations as to possible future applications of laser radiation are also presented. (BBB)

18146 RELATIONS BETWEEN RADIODERMATITIS AND PAIN (HISTOLOGICAL AND MORPHOLOGICAL STUDY). Manzoni, S. (Univ., Milan). Arch. Ortoped., 78: 47-53(1965). (In Italian).

A microscopic examination of neural receptors in skin was performed in 30 patients who developed dermatitis as a result of radiotherapy. The chronic dermatitis in these cases was associated with pain of moderate-to-severe intensity. Pacinian corpuscles and nerve bundles with changes attributable to radiation were found in 25 cases, whereas only nerve bundles exhibited changes in 5 cases. The Pacinian corpuscles in a hypertrophic phase showed more voluminous than normal concentric layers of cells, with vacuolation and granulation of nuclei. The central zone of the corpuscles was dilated and the interlamellar space was widened. Later a degenerative phase in these receptors was noted. A comprehensive survey of the literature of the subject revealed that in all probability the sometimes very intense pain in radiodermatitis is due to a primary irradiation-induced change in the pressure-sensitive Pacinian corpuscles. The peripheral nerve bundles, also subject to radiation damage, are also capable of transmitting pain-producing stimuli. (BBB)

18147 APPLICATION OF RADIOBIOLOGY TO THE STUDY OF HELMINTH DISEASE. Mulligan, W. (Glasgow Univ.). World Vet. Congr., Proc., 17, Hanover, 1: 831-2(1963).

When infective parasite larvae are irradiated, their capacity to develop normally in the host is impaired and fewer larvae develop to adults, the reduction being proportional to the dose of radiation used. With some species of helminths it has been shown that the male larvae are more radiosensitive than the females so that worm populations consisting entirely of sterile females may arise from the irradiated preparations. In the case of parasites which have a migratory phase in their life cycle, this too can be seriously interfered with. Suitably irradiated larvae can be of great value in parasitological research, particularly in immunoparasitology. The inverse relation between the numbers of worms which develop and radiation dose used means that it is possible to produce preparations of larvae at different levels of inactivation and correspondingly different degrees of pathogenicity. Some loss of immunogenic power may be associated with the inactivation but it is often possible, by a suitable choice of radiation dose, to obtain larvae whose pathogenicity has been significantly reduced without serious loss of immunizing potency. Such larvae can be used for artificial immunization. When an animal has experienced two infections with a parasitic helminth it is often difficult to distinguish between the different populations of worms and therefore impossible to assess the immunizing effect, if any, of the primary infection. If, however, the primary infection is carried out with suitably irradiated larvae and the second one with normal larvae, the worms originating from each may be easily distinguishable as the primary infection will have resulted largely in sterile females. The relative immunological importance of different phases in the life cycle of a migratory parasite such as N. muris may be studied by using larvae irradiated at different levels. (BBB)

18148 BIOLOGICAL EFFECTS OF HIGH PEAK POWER RADIATION. Fine, S. (Northeastern Univ., Boston); Maiman, T. H.; Klein, E.; Scott, R. E. Life Sci., 3: 209-22(Mar. 1964).

Biological effects of ruby laser radiation at high peak power (>10^8 W) and at high peak power density (>10 W/mm^2), but relatively low energy levels (3 J), were studied. Qualitative as well as quantitative differences due to variations in peak power and in power density at equivalent energy levels of laser radiation were considered. Similarities of the biological effects of laser

radiation at high peak power and low energy and those at low peak power and higher energy output were noted. Damage to mouse skin and underlying structures was observed at high peak powers (exceeding 10 MW) and energy levels of 3 J. At lower peak powers (10 KW) at 7 J and corresponding pulse durations of the order of 1 msec, considerably less or no damage to the skin was observed. Necrosis was produced in irradiated melanomas, and damage within tumors was more extensive than superficial lesions suggested. Microscopic changes following high peak power irradiation were demonstrated in melanomas, skin lesions, and in underlying lesions of the liver. Histologic changes in melanomas confirmed the presence of two types of necrosis; these were suggested by the appearance of the gross specimens. The type of necrosis produced directly by laser irradiation showed sharp linear demarcation of irradiated from adjacent nonirradiated areas of the tumor. The second type of necrosis was focal in distribution and closely resembled the appearance of spontaneous necrosis in rapidly growing melanomas. The irradiated animals survived the effects of high and of low peak power radiation. Electrocardiographic tracings during and after irradiation indicated transient and inconsistent changes in rate and voltage of the heart. (BBB)

18149 EARLY BIOCHEMICAL CHANGES IN LYMPHATIC CELLS FOLLOWING IONIZING RADIATIONS. Scaife, J. F. (EURATOM-CCR, Ispra, Italy). pp 309-23 of Proceedings of the International Symposium on the Cell Nucleus: Metabolism and Radiosensitivity. London, Taylor and Francis, [1966].

A brief review is made of the early post-irradiation biochemical changes that have been observed to occur in lymphatic cells such as thymocytes, and that can most plausibly be directly correlated with the observed morphological changes of nuclear homogenization and pyknosis. The breakdown of nuclear deoxyribonucleoprotein into polymerized DNA and histone and the influence of various metabolic inhibitors on this process was found to correlate well with the morphological changes. An aerobic metabolic process is required for these changes, which can be greatly accelerated by inorganic phosphate in the suspension medium of the cells. (auth)

18150 SIGNIFICANCE OF THIOL GROUPS IN NORMAL AND IRRADIATED NUCLEI. Stocken, L. A.; Ord, Margery G. (Oxford Univ.). pp 141-6 of Proceedings of the International Symposium on the Cell Nucleus: Metabolism and Radiosensitivity. London, Taylor and Francis, [1966].

It is important to determine the function of the different thiol compounds so far identified in nuclei and to find out which of these components are involved in the radiation response. The function of phosphate and thiol groups in histones was explored. Increases in the phosphate content of histone f_1 could be produced by incubating rat thymus nuclei with inorganic phosphate. Oxidation of histone f_3 or bridging with a bifunctional mercury compound reduced the capacity of DNA to support DNA-dependent RNA synthesis. Changes were found between the phosphate and thiol contents of histone extracted from diffuse and dense chromatin. (auth)

18151 OSMOTIC CONCENTRATION OF THE CONTRACTILE VACUOLE OF AMOEBA PROTEUS FOLLOWING UV-LIGHT IRRADIATION. Mayer, L. M.; Iverson, R. M. (Univ. of Miami, Coral Gables, Fla.). Experientia, 23: 120(Feb. 15, 1967).

About 10% of the uv-irradiated cells show enlarged contractile vacuoles, compared to 1% of a control cell group. However, there is no significant difference in the milliosmolal concentrations of the enlarged and unenlarged vacuoles in either group. (C.O.)

18152 INJURY DUE TO ACCIDENTAL HIGH-DOSE EXPOSURE TO 10 MeV ELECTRONS. Lanzl, Lawrence H. (Argonne Cancer Research Hospital, Chicago); Rozenfeld, Martin L.; Tarlov, Alvin R. Health Phys., 13: 241-51(Mar. 1967).

An industrial worker was accidentally exposed to a 10-MeV electron beam from a linear accelerator. Dosimetric information was assembled immediately after the event, and later, through a reconstruction of the accident. The dose gradient about the primary electron beam was high, giving estimated doses to various parts of the right hand which ranged from 40,000 to 240,000 rad. The interior of the body received doses ranging from 0.2 to 5 rad. These measurements of the internal dose were consistent with estimates made immediately after the accident based on the victim's film badge reading and calculations of bremsstrahlung formation in the skin of the chest from a highly scattered electron beam. This early estimate had provided great confidence that the injured worker would survive, since the blood-forming tissues would not have been impaired by these dosages. Clinical observations pertaining to the development of skin changes and loss of neurologic function in the hand and leg led to much lower estimates of the dosage received by these extremities than the physical dosimetry later provided. This case illustrates that the ultimate extent of tissue injury and necrosis cannot be as yet anticipated from early clinical observation. The late, or delayed, effects of irradiation eventuated in double amputation 5 to 6 months after exposure. Experimental data in primates are badly needed to provide a foundation for prognosis and a guide to therapy of injured humans. (auth)

18153 DOSE RATE EFFECT OF RADIATION ON SPERMATOGONIA OF THE SILKWORM. Sugai, E.; Iijima, T. (Tokyo Univ. of Agriculture and Technology). Nature, 213: 943-4 (Mar. 4, 1967).

The effects of dose-rate on death and repopulation of γ-irradiated spermatogonia of silkworms were analyzed cytologically with particular reference to the possibility of selective elimination of the cells after exposure to different dose-rates. Total doses of 1000 R were administered by acute or chronic exposure. It was found that pycnosis was maximal at 48 hrs post-irradiation in cells receiving acute doses, a peak reached at 72 hrs post-irradiation in chronically irradiated cells. Non-pycnotic spermatogenic cells were reduced remarkably after both dose-rates, although apical cells, primordial germ cells and some young spermatogonia remained intact. Survival patterns of these cells indicated inhibition of cell division. Extent of spermatogonial death and number of surviving or newly formed cells were comparable at both dose-rates. It is concluded that cell selection is not involved in the dose-rate effect on mutation frequency in the spermatogonia of silkworms. (H.G.D.)

18154 THE DEPENDENCE OF THE GROWTH OF GUERIN CARCINOMA FROM THE SITE OF INOCULATION AND FROM THE IMMUNITY OF RATS. Kulesza, Barbara (Inst. of Oncology, Warsaw). Nowotwory, 16: 318-26(Oct.-Dec. 1966). (In Polish).

Growth was compared for Guérin Carcinomas inoculated in three different tissues of rats. In some of the rats the degree of immunity was lowered and in others it was increased. The suspension of Guérin Carcinoma was inoculated to the muscular, adipose, and subcutaneous tissues. The immunity of rats was lowered in three different ways, by thymectomy, by x-irradiation, and by cortisone treatment. The immunity of rats after these treatments was compared with the immunity of a control group. An increase of immunity was achieved by injecting isologous antiserum or by injecting antigenic material of Guérin tumor (frozen and dried tissue) ten days or 24 hours respectively before tumor inoculation. In the control group the rats did not undergo any treatment before tumor inoculation. On the 16th day after the inoculation of tumor the rats were sacrificed and the tumors were cut out and weighed. It was found that the biggest tumors developed in the muscular tissue, smaller ones in the adipose tissue, and the smallest in the subcutaneous tissue. These differences in the growth of tumors were significant and occurred in all experimental groups of rats. The tumors of thymectomized rats and of x-irradiated ones were bigger than tumors in control rats, but in the rats treated with cortisone the tumors were smaller than in the control group. The average weight of tumors in rats injected with antiserum and in those immunized with the antigenic material were generally bigger than the weight of tumors in the corresponding control group. However these differences were not always significant. (auth)

18155 SELECTED BASIC PROBLEMS OF PROTECTION AGAINST RADIATION. Jasinski, Wladyslaw (Inst. of Oncology, Warsaw). Nowotwory, 16: 369-78(Oct.-Dec. 1966). (In Polish).

Recent medical literature (papers published after 1960) dealing with the risk involved in the exposure of the living organism to ionizing radiation is reviewed. Data from selected publications are presented. Special attention is given to the effects of small doses of radiation on the incidence of genetic defects, leukemias, other malignancies, and eye lesions. Aging and fertility phenomena are also discussed. (auth)

18156 DIVISION PROBABILITY AND RADIATION INDUCED CELL DEATH. James, A. P. (Chalk River Nuclear Labs., Ont.). Nature, 213: 843-4(Feb. 25, 1967).

It is stated that the non-surviving members of an irradiated sample of cells may vary considerably in their mitotic behavior – some fail to divide, others divide once, and abortive clones of various sizes are not infrequently produced. This heterogeneous response has usually been considered evidence that lethal irradiation damage is of several types. It has been suggested, however, that these different responses may be manifestations of the same type, and even the same degree, of damage. A unifying concept of cell death termed division probability has been proposed which, if correct, would drastically alter the current interpretation of dose-survival curves. The present communication discusses this concept (due to Whitmore and Till, Ann. Rev. Nucl. Sci. 14: 347 (1964)), including methods of treating it. The test is best carried out through straightforward observation of repeated cell divisions in an organism, such as yeast, which is amenable to cell-pedigree analysis, and some studies with

this organism are described. The pattern emerging from these studies is not that expected of the concept, and it is concluded that to be acceptable for yeast the concept would have to be altered so drastically as to lose the practical usefulness claimed for it. (auth)

18157 SOME NEURO-HORMONAL MECHANISMS OF THE REACTION TO IONIZING RADIATION. Lebedinskii, A. V.; Klimovskaya, L. D.; Smirnova, N. P. (Inst. of Medico-Biological Problems, Moscow). Physiol. Bohemoslov., 15: 459-65(1966).

Changes in vasomotor reactions were studied in irradiated animals from the point of view of nervous and hormonal mechanisms involved in the response to ionizing radiation. It was shown that besides changes in the extent and shape of vasomotor reactions elicited by stimulation of sympathetic nerves, hypothalamic stimulation or adrenaline administration, the hormonal activity of hypothalamic extracts and impairment of catecholamine and acetylcholine metabolism in sympathetic ganglia were changed in irradiated animals. Hypothalamic stimulation that leads to increased antidiuretic activity in the blood plasma and vasoconstriction in healthy animals, evoked in most irradiated animals vasodilatatory effects and was without effect upon the antidiuretic properties of blood plasma. An explanation of the changes taking place in the state of effector systems of the irradiated organism, which often respond to adequate stimuli by reversed or altered reactions, is offered in the results. (auth)

18158 BASIC MEDICAL PRINCIPLES SERVING AS THE BASIS FOR THE REGULATIONS ON IONIZING RADIATIONS. Lafontaine, A. (Institut d'Hygiene et d'Epidemiologie, Brussels). Bull. Inform. Ass. Belge Develop. Pac. Energ. At., 11: No. 63, 3-6(Aug. 1966). (In French).

In order to comprehend the relations that can be established between irradiation and the biological effects and to attempt to derive the basic medical protection principles, the radiobiological factors constituting the irradiation conditions and the general characteristics of radiolesions or of subsequent ailments are reviewed. Particular radiopathological ailments and the dose-effect relation and radioprotection are outlined. (J.S.R.)

18159 ACQUIRED RADIORESISTANCE OF TRANSPLANTED MAMMARY ADENOCARCINOMA IN INBRED MICE AFTER SERIAL IRRADIATION. Hoffman, Neil A.; Gollin, Frank F.; Clifton, Kelly H. (Univ. of Wisconsin, Madison). Radiology, 88: 568-75 (Mar. 1967).

The clinical phenomenon of acquired radioresistance, an old and controversial problem to both radiotherapist and experimentalist, is critically discussed. To mimic the clinical situation, a spontaneous mouse mammary adenocarcinoma was irradiated with various regimes in each of ten serial transplant generations. The tumor subline (designated MTG-B) which received the most highly fractionated treatment was seen to develop acquired radioresistance by clinical, pathologic, and cytologic criteria. By quantitative cell survival assay following irradiation in vivo, the tumors of this subline were found to be relatively radioresistant. (auth)

18160 COMPOSITE THEORY OF AGING. Curtis, Howard J. (Brookhaven National Lab., Upton, N. Y.). Gerontologist, 6: 143-9(Sept. 1966). (BNL-10204).

Four principal theories of aging are critically examined, the evidence relating ionizing radiation to the somatic mutation theory of aging is reviewed, and a composite theory is developed which encompasses the somatic mutation concept. Ionizing radiation, applied to animals or man, shortens life expectancy by an amount roughly proportional to the dose received, and the causes of death are similar to those for natural aging. In natural aging, chromosome aberration frequency increases steadily with age, so that, for example, in old mice of some strains 75% of all liver cells contain abnormal chromosomes. After irradiation also, aberrations increase markedly. For different kinds of radiation, the increase in aberration frequency is proportional to the life shortening produced. Different radiation regimes produce characteristic amounts of life shortening, and for each the chromosomal damage produced is proportional to the life shortening. Each inbred strain of mouse has a different life expectancy and long-lived strains develop mutations at a slow rate and the short-lived ones at a fast rate. Thus, qualitative and quantitative correlations between development of chromosome aberrations and induction of the degenerative diseases can be shown. Although mutations seem to play an important, and perhaps dominant, role in aging, the mutation theory as it now stands is inadequate. Difficulties with the simple interpretation of the mutation theory based on radiation studies are outlined. For radiation-induced aging, it is difficult to explain the long delay between the production of a mutation and the manifestation of the disease. Also, chromosomal recovery occurs, and at the time chromosomal aberrations are returning to normal, the death rate begins to increase. A mutation hypothesis of aging will not predict the proper shape of the mortality curve for mammalian populations. In the composite theory of aging which is developed here, a multistep process is envisioned, with radiation acting only at some stages and requiring other factors for complete manifestation of aging phenomena. (BBB)

18161 ATOMIC BOMBS, INBREEDING, AND JAPANESE GENES: THE RUSSELL LECTURE FOR 1966. Neel, James V. (Univ. of Michigan, Ann Arbor). Univ. Mich. Med. Center, 32: 107-16(May-June 1966).

Genetic effects observed in survivors, and their descendants, of the Hiroshima and Nagasaki atomic bombings are reviewed. The possible indicators of genetic damage studied were frequency of stillbirth, frequency of major congenital defects, sex of child, birth weight, and death during infancy and childhood. By 1953 extensive information had been collected on the outcome of 71,280 births in the 2 cities and statistical analysis was undertaken. A questionable relation between exposure to radiation and the sex ratio was noted. When mothers had been exposed, there appeared to be a slightly larger proportion of females among their offspring, whereas when fathers had been exposed, there was a slightly greater proportion of males. The results would probably be expected if radiation had produced mutations on the sex chromosomes or increased the frequency of occurrence of nondisjunction of the sex chromosomes. However, in a later study, such an effect of radiation on the sex ratio could no longer be seen. The final interpretation was that there had been no effect of radiation on the sex ratio, but a hypothesis which could not be excluded is that a small, early effect has now disappeared. Some observations which support this possibility are discussed. Another study on the genetic effects of inbreeding in some Japanese populations is also described. The relatively low accumulation factor revealed by this and other studies of inbreeding, as well as direct studies of the effects of recessive genes in the single or heterozygous state, were interpreted to indicate that selection even against so-called recessive genes occurs to a large extent in the heterozygous condition. Thus any radiation-induced increase in mutations (including chromosomal as well as point mutations) might be expected to manifest itself promptly. The proportion of children who die each generation because of mutation in the preceding generation is estimated to be between 0.5 and 1%. The data from Japan leave only a 1 in 10 chance of an increase in the death rate greater than 1% prior to reproduction. This fact plus the knowledge of the radiation exposures in Hiroshima and Nagasaki permitted calculations of the amount of radiation necessary to increase the spontaneous mutation rate by 100%, i.e., the so-called doubling dose. It is unlikely that in Hiroshima and Nagasaki this doubling dose was less than 50 R. (BBB)

18162 EFFECTS OF X IRRADIATION ON MORTALITY AND ABNORMALITY OF THE CHICKEN EMBRYO. Katsuragi, Toshimatsu; Saeki, Yuichi (National Inst. of Animal Industry, Chiba, Japan). Chikusan Shikensho Kenkyu Hokoku, No. 2, 201-8(1963). (In Japanese).

The effects of x irradiation on the mortality and the incidence of abnormalities in chicken embryos were studied. A total of 1454 fertilized eggs from White Leghorn chickens were irradiated at dose levels of 800 and 1000 R. Incubated eggs were examined by candling at 4 periods postirradiation: 1-5, 6-10, 11-15, and 16-20 days. The age of dead embryos was estimated by comparing their size with that of normal embryos. After irradiation, more than 80% of the embryos died during the incubation period. Death of the embryos occurred soon after irradiation; at the dose level of 1000 R rapid death was observed. The lethal effect of 800 R was generally more prolonged, and most of the irradiated eggs died 18 to 20 days postirradiation. No definite relation was found between mortality rate and the developmental stage at which embryos were irradiated; however, a high incidence of mortality was observed in eggs irradiated during 1st to 4th day of incubation. Abnormalities induced by x irradiation were mostly found after the 11th day of incubation and the incidence rate was 4.7%. The incidence of normal hatching was 2.0%. Most of the abnormalities consisted of crooked beaks, shankless feet, bent shanks, missing toes, and fused toes. (BBB)

18163 NONSPECIFIC ENDOTOXIN-LIKE RESISTANCE INDUCED BY SIMPLE CHEMICAL COMPOUNDS. Raskova, Helena (Charles Univ., Prague). pp 546-61 of Bacterial Endotoxins, Proceedings of a Symposium, Rutgers, The State Univ., New Brunswick, N. J., 1963. New Brunswick, Rutgers, 1964.

The ability of an injection of bacterial endotoxin to increase tolerence to subsequent administration of toxin, whole-body irradiation, and other noxious agents is reviewed. A typical pattern of endotoxin-induced elevated resistance is measured by changes in lethality, or time of survival, after intoxication, infection, shock, or irradiation. In the standard procedure now used, changes in

lethality to bacterial toxins are expressed by comparisons of LD_{50} of treated and control animals. Endotoxin-type increased resistance was also demonstrated with whole-body irradiated animals. The same procedure as for chemical toxicity tests was used. One group of mice was pretreated with phenol, another served as control (saline injections), and a third group was given procaine. Mortality comparisons were made among animals of all groups after whole-body x-ray exposure (650 R). The mortality was followed for 15 days. After 10 days, differences in mortality were highly significant. At 10 days, mortality was 15% in phenol-pretreated mice, 25% in those pretreated with procaine, and 30% in irradiated controls. At 15 days, the respective mortality figures were 25, 35, and 55%. It is seen that phenol and procaine have properties resembling those of endotoxin when injected prior to irradiation. (BBB)

18164 CLINICAL EVALUATION OF RADIOTHERAPY FOR ORAL CANCER. 2nd REPORT: ON RADIATION-INDUCED MANDIBULAR NECROSIS. Kobayashi, Ichiro; Takagi, Harushiro; Yokoyi, Koshio; Wakaki, Nobiru; Okuhara, Seiyu; Tadimo, Iro; Machusmoto, Chi; Komura, Techuro (Kanazawa Nationl Hospital, Japan). Koku Geka Gakkai Zasshi, 8: 253-62(1962). (In Japanese).

The occurrence of mandibular osteoradionecrosis in 25% of 20 cases treated for oral cancer during a 10-yr period (1951 to 1961) is reported. Of these 20 cases there were 7 cases of maxillary cancer, 3 of mandibular cancer, 5 of tongue and palate cancer, 3 of tonsil and larynx cancer, and 2 with lip and cheek cancer. The mortality rate was 60%. A fractionated telecobalt method was used, along with Ra and Rn implants, chemotherapy, and surgery. The mandible was included in the radiation field in 10 cases, and 5 of these developed septic osteoradionecrosis. Without extraction of teeth prior to irradiation, the rate of this complication probably would have been even higher since bacterial infection was more likely to occur; the production of oral mucositis predisposes tissues toward infection. Special dental care was required in orally irradiated patients to prevent such sequalae. Mandibular osteoradionecrosis may lead to severe trigeminal nerve pain; the best treatment for this pain was found to be surgical excision of the mandible after the inflammation stage had passed. (BBB)

18165 BIOLOGICAL EFFECTS OF IONISING RADIATION ON THE THYROID GLAND. Philp, J. R. (Univ. of Aberdeen, Scotland). Postgrad. Med. J., 42: 437-42(July 1966).

Radiobiology of the thyroid is reviewed, particularly in relation to the high incidence of iatrogenic hypothyroidism (40% 8 yr after treatment) in thyrotoxic patients treated with radioiodine. Clinical observations point to the basic conflict in radioiodine therapy, i.e., that high doses effect rapid control but cause a high hypothyroid rate; lowering the dose decreases the hypothyroid rate but lengthens the period for control of symptoms unless antithyroid drugs are used. In the case of deliberately induced mild hypothyroidism in patients with angina pectoris the dose required is large (e.g., 50 mC) compared to that normally used in the treatment of thyrotoxicosis (5 to 15 mC). This difference probably results from the higher percentage uptake of the administered dose by the cells of the thyrotoxic gland. On the other hand, unknown biological phenomena may be operating to produce this disparity in apparent radiosensitivity. In adults no significant incidence of thyroid cancer has been found either after external x-ray therapy or after radioiodine therapy. In children and adolescents, however, a definite association between external irradiation of the neck and the subsequent development of thyroid cancer has been established. Another possible biological hazard of radioiodine therapy is leukemogenesis, but as yet no significant incidence of this has been reported. The purpose of radioiodine therapy is to achieve a radiation-induced partial thyroidectomy, but it remains to be seen if this is possible within a reasonable period of time. Clinical trials so far have not been conclusive and it is more likely that the solution will come from purer radiobiological situations in which fundamental changes in cell behavior following irradiation can be assessed in a quantitative manner. (BBB)

18166 STUDIES OF THE MECHANISM OF ULTRAVIOLET ERYTHEMA FORMATION. III. A METHOD FOR BIOLOGICAL TESTING OF ULTRAVIOLET RADIATION SOURCES AND SUBSTANCES AFFECTING THE DEGREE OF ERYTHEMA. Valtonen, Erkki J. (Univ. Central Hospital, Helsinki). Acta Dermato-Venerol., 46: 292-300(1966).

A method is described for biological testing of uv radiation sources and substances affecting the degree of erythema after exposure that uses the ear of young mice as the test material. The other ear of the mouse serves as a control. The degree of the erythema is estimated visually and given a score of 0 to 5. The results undergo statistical treatment to determine the significance of the changes. The value and accuracy of the method was demonstrated by testing the erythematous effect of 2 uv lamps. In addition, the effects of 8-methoxy-psoralen and Irgapyrin or the development of uv erythema were investigated. It had previously been shown that prolonged exposure to uv light caused severe erythema damage in psoralen-treated mice. In the present experiment, however, only an immediate erythema response was recorded and there was no increase in the intensity of the erythema. Thus, psoralen increases development of erythema only after prolonged administration and repeated irradiation. Irgapyrin, a drug used for the treatment of rheumatic disorders because of its anti-inflammatory properties, had a delaying effect on the development of uv erythema. (BBB)

18167 STUDIES ON DELAYED CUTANEOUS INFLAMMATORY REACTIONS ELICITED BY INOCULATION OF HOMOLOGOUS CELLS INTO HAMSTERS' SKINS. Ramseier, Hansruedy (Univ., Zurich); Billingham, R. E. J. Exp. Med., 123: 629-56 (Apr. 1, 1966).

Cutaneous reactions in various strains of hamsters to injection of homologous lymphocytes were examined in experiments employing x radiation and cortisone to diminish circulatory leukocyte levels in recipients. X irradiation (1500 rad) caused severe lymphocytopenia within a few hours followed by a more slowly progressing granulocytopenia, and cortisone caused severe lymphocytopenia accompanied by a granulocytosis. It was concluded that some cellular response or contribution from the host is essential for development of transfer reactions. That the essential influence of the irradiation was not simply impairment of the iso-antigenicity of the host's skin was established on the basis of homotransplantation tests with irradiated skin. Host cells of hematologic origin, rather than indigenous skin cells, contributed the antigenic stimulus required for these reactions. The various delayed inflammatory reactions described are manifestations of immunological responses on the part of immunologically competent cells against alien transplantation antigens. (TSS)

18168 HOMO- AND HETEROTRANSPLANTATION. Caine, Roy Y. (Univ. of Cambridge, Eng.). Curr. Probl. Surg., 3-56 (Apr. 1966).

Problems in grafting organs and tissues are discussed, with reference to the use of ionizing radiations under various circumstances to prevent host-vs-graft reactions. It is pointed out that very high doses of radiation are necessary to prevent rejection of homologous tissues. It is necessary to destroy the hematopoietic tissue in bones to inhibit rejection of renal homografts. Results of studies on dogs showed that typical rejection of renal homografts occurred when doses of whole-body x radiation below 1000 R were given and rejection was inhibited at doses above 1300 R. Sublethal doses of whole-body x radiation resulted in the survival of homologous marrow grafts from near relatives in rats and prolonged the survival of skin grafts from closely related donors in mice. A case is reported of successful renal transplantation between nonidentical twins, in whom there was a close correlation of erythrocyte groups, following exposure of the patient to 450 R whole-body irradiation. Less successful results in other patients are summarized. The use of bone marrow transplants following whole-body irradiation for the treatment of leukemia is discussed. It is concluded that the treatment may hasten the death of the patient. (TSS)

18169 EXPERIMENTAL TYPHUS INFECTION AND IMMUNITY IN IRRADIATED ANIMALS. II. EFFECTS OF TOTAL IRRADIATION ON IMMUNITY FROM TYPHUS FEVER. Krasnik, F. I.; Goldin, P. B. Tr. Inst. Epidemiol., Mikrobiol. Gig. Pastera, 25: 42-9(1963). (In Russian).

Experiments were conducted on rats in which the titers of specific typhus antibodies were within the limits of 1:40 to 1:60 or higher. To ascertain the influence of ionizing irradiation on immunity, immune rats were irradiated with sublethal doses of x rays (500 R), which was followed by a test of their resistance to a second infection by virulent typhus rickettsiae. Nonirradiated and nonimmune animals of the same weight, irradiated simultaneously with the immune ones, served as controls. Thus 3 groups were studied: (1) immune–irradiated, (2) immune–non-irradiated, and (3) nonimmune–irradiated. Two days after irradiation all the animals were inoculated intraperitoneally with typhus rickettsiae. Blood smears were made at various intervals for microscopic study. Irradiation of the rats which were immune to typhus led to a partial depression of their secondary immune response. However, in spite of this depressing effect of ionizing radiation on anamnestic immunogenesis, residual immunity provided a higher resistance to the typhus agent than that in nonimmune rats. Attempts at augmentation of the virulence of the typhus agent in immune rats by irradiation gave negative results, indicating that the level of specific antibodies in immune rats is adequate to counteract the resistance-lowering effect of irradiation on infectivity. (BBB)

18170 EXPERIMENTAL TYPHUS INFECTION AND IMMUNITY IN IRRADIATED ANIMALS. I. COURSE OF TYPHUS INFECTION IN COTTON RATS SUBJECTED TO X-RAY IRRADIATION. Goldin, P. B.; Krasnik, F. I.; Bishnyakova, L. A. Tr. Inst. Epidemiol. Mikrobiol. Gig. Pastera, 25: 32-41(1963). (In Russian).

More than 120 cotton rats weighing 30 to 60 g were irradiated with a 500 to 600 R total dose of x rays. Two days after irradiation (the optimum period for max effect) the rats were infected intraperitoneally with typhus rickettsiae (Breinl strain). Smears of blood, exudations from the abdominal cavity, scrapings from the peritoneum, imprints from the vaginal mucosa and testes, sections of spleen, liver, kidney, adrenal gland, lymph nodes, lung, brain, and other organs were prepared by fixing in ethyl alcohol and staining for daily observation of organ changes up to a period of 20 days. Most of the rats died within 10 days after irradiation, with only 2 living past the 20-day observation period. Whole-body irradiation led to a marked lowering of the rats' nonspecific resistance, so that their susceptibility to infection by rickettsiae sharply increased. This was borne out by the fact that irradiated rats sickened and died sooner than did nonirradiated ones which had also been infected. Rickettsiae in irradiated rats rapidly and intensively multiplied, beginning with the 2nd to 3rd day after inoculation, exceeding the microbial count in nonirradiated rats hundreds and thousands of times. The infectious agent also penetrated the blood and was disseminated into all organs and tissues. In nonirradiated animals by the 10th day after infection, rickettsiae were no longer evident in the tissues, whereas in the irradiated ones the protective processes apparently were inhibited and the agent continued to multiply until death of the rat. (BBB)

18171 EFFECT OF UV IRRADIATION ON NONSPECIFIC CONTROL OF INFECTION, ESPECIALLY ON THE PROPERDIN-COMPLEMENT SYSTEM. Reissmann, G. (Bezirkskrankenhaus, Plauen, Ger.). Arch. Phys. Therap., 17: 95-8(Mar.-Apr. 1965). (In German).

The effects of uv irradiation treatment on the titer of serum properdin were studied in 15 samples from normal patients. The patients were irradiated every second day up to 23 days for intervals of 2 to 11 min by quartz Hg lamp at a distance of 80 cm. Blood samples were taken every three days. Comparison of the properdin titers before and after irradiation did not show any statistically significant differences. The titer decreased slightly as a result of blood sampling, suggesting an indirect stimulation of the properdin system. Thus, uv irradiation had no effect on the properdin titer. (BBB)

18172 INHIBITION OF THE AFFERENT ARC OF THE IMMUNE RESPONSE TO RENAL HOMOGRAFTS BY LOCAL GRAFT RADIATION. Kauffman, H. Myron Jr. (Univ. of Kentucky, Lexington); Cleveland, Richard J.; Robertshaw, Gilbert E.; Graham, Walter H.; Hume, David M. Surg. Gynecol. Obstet., 123: 1052-6 (Nov. 1966).

Local graft irradiation, as the sole method of therapy, prolongs significantly the survival time of renal homografts in dogs. Whether or not local graft irradiation affects cellular components of the afferent limb of the immune response was investigated. The ability of local irradiation to prevent host sensitization to first-set kidney homografts was assessed by transplanting an untreated second-set graft from the same donor. Control second-set grafts characteristically undergo accelerated rejection. Since the second-set grafts received no treatment, any prolongation of their function must be due to inhibition of the afferent arc of the immune response to the primary graft. Local graft irradiation consisted of 6 daily doses of 150 R, the first dose being administered on the day of transplantation. Azathioprine, of value in prolonging renal homograft survival, was also used so that the results of local graft radiation could be compared. The mean functional survival time for controls with second-set grafts was 1.8 days, in contrast to 3.3 days in dogs receiving radiation and 4.2 days with azathioprine. The results indicated that local graft irradiation interferes with the afferent arc of the immune response. Since the total dose of 900 R used was too small to alter antigenicity of the graft, it is speculated that irradiation interfered with the host cells which play a role in antigen release or transport to the antibody centers of the host. Local graft irradiation may also exert some effect by reducing edema. Reduction of the vascular supply with mechanical interference of nutritional exchange of tissue probably plays a significant role in transplant destruction. (BBB)

18173 PHYSICOCHEMICAL CHARACTERIZATION OF NATURALLY OCCURRING ANTIBODIES TO GRAM-NEGATIVE BACTERIA. Michael, J. Gabriel; Rosen, Fred S. (Children's Hospital Medical Center, Boston). pp 306-10 of Bacterial Endotoxins, Proceedings of a Symposium, Rutgers, The State Univ., New Brunswick, N. J., 1963. New Brunswick, Rutgers, 1964.

Evidence that continuous antigenic stimulation is responsible for the maintenance of the constant levels of natural antibodies was obtained from experiments with irradiated animals. Earlier experiments showed that irradiation of mice, even with lethal doses, did not affect the titers of naturally occurring bactericidal antibodies. In later experiments, mice were irradiated with a dose of 700 R and divided into groups: some animals were injected with somatic antigen 24 hr prior to irradiation, others 24 hr after the irradiation. Irradiated animals which were not given endotoxin maintained unchanged levels of natural antibodies. Unirradiated mice injected with somatic antigen developed within a week increased levels of bactericidal antibodies. Irradiated mice administered endotoxin 24 hr prior to irradiation contained similarly increased amounts of antibodies. The animals given the antigen 24 hr after the irradiation continued as previously to produce low levels of natural antibody but exhibited no rise in titer. Irradiation was assumed to interfere with the inductive phase of antibody formation. Since antigen which evokes natural antibody responses is already present in the host at the time of irradiation, the anticipated result that such antibody formation would continue was confirmed. (BBB)

18174 REDUCED SENSITIVITY OF F_1 HYBRID RATS TO RECHALLENGE WITH PARENTAL STRAIN SPLEEN CELLS. Field, E. O.; Gibbs, J. E. (Royal Cancer Hospital, Sutton, Eng.). Clin. Exp. Immunol., 1: 195-205(Apr. 1966).

F_1 hybrid rats that recovered from graft-vs-host (GVH) disease induced by the intraperitoneal injection of spleen cells of one parental strain showed varying degrees of resistance on rechallenge with cells of the same or of the other parental strain. Resistance to rechallenge, expressed either in terms of mortality or of severity of clinical manifestations, was greater after a strong than after a weak response to first challenge. Resistance was shown not to be due to immunization of the F_1 hybrid. Resistant rats accepted skin grafts from both parental strains; resistance was not produced by the injection of thymic cells or of irradiated spleen cells; lethally irradiated thymectomized rats were able to develop resistance. Radiation was given in total doses of either 800 R as 2 daily fractions of 400 R each, followed 1 day later by intravenous infusion of 125 million syngenic bone marrow cells, or 500 R given in one fraction. Two possible explanations of this phenomenon are discussed: (1) resistance is due to reactive hyperplasia of the recipient's lymphoid system; and (2) parental lymphoid tissue contains humoral antibody-producing cells; the isoantibodies mask antigenic sites on the recipient's target tissues from the action of cells responsible for inducing a GVH reaction, by a mechanism analogous with that of tumor enhancement. (BBB)

18175 GROWTH AND SENESCENCE OF ANTIBODY-FORMING CELLS. Albright, J. F.; Makinodan, Takashi (Oak Ridge National Lab., Tenn.). J. Cell Physiol., 67: No. 3, Pt. 2, 185-206(June 1966). (ORNL-P-2127).

The interrelations of radiation, progenitor cell depopulation, and senescence are discussed from the standpoint of the long-term effects on life expectancy of chronic radiation exposure. Radiation exposure during juvenility and young adulthood appreciably reduces mean survival time of rodents. The question of the extent to which a depleted population of pluripotential progenitor cells would be able to renew itself after radiation is considered. The fact that there is loss during senescence of the number of immunologically competent cells means that attrition in the efficiency of progenitor cell self-renewal occurs. Some radiation experiments on the suitability of the environment of both young and old mice for expression of immunologically competent cells are described. In one experiment very young and very old, irradiated mice were used as recipients in which to culture primed spleen cells from syngeneic donors. Results showed that 8-day-old and the 100-week-old mice are equally satisfactory for production of antibody by primed progenitor cells and their progeny. Moreover, antibody production in both the old and young recipients was equivalent to that obtained from cells of young-adult donors cultured in young-adult recipients. Experiments are also presented on the growth of donor spleen cells in irradiated recipients and on attempts to rejuvenate old mice by irradiation and transplantation of spleen cells. These experiments indicated that decline in both number and performance, but especially number, of progenitor cells plays a causative role in the onset of senescence and subsequent death. (BBB)

18176 RADIORESISTANCE OF LIVING ORGANISMS IN THE EARLY POSTRADIATION PERIOD. Yarmonenko, S. P. (Inst. of Industrial Hygiene and Occupational Diseases, Academy of Medical Sciences, USSR). Dokl. Akad. Nauk SSSR, 168: 1411-14(June 21, 1966). (In Russian).

The hypothesis of M. M. Elkind that an initial increase in the radioresistance in animals is connected with the early elimination of sublethal injuries owing to the restoration and radiosensitive systems was investigated. Experiments were performed on 655 female white mice weighing 20 to 22 g and on 80 female white mice weighing 26 to 28 g. Whole-body x irradiation was done in a uniform field at 15 mA, 180 kV, at a dose rate of 37 R/min with 0.5 mm Cu + 1 mm Al filters. The criterion for determining the stage of radioresistance within the range of doses which cause "bone marrow death" was 30-day survival of the animals following two exposures to doses of 300 and 420 R at intervals of 1.5, 3, 6, 9, 12, 18, and 24 hr as compared with survival following a single irradiation by a 720 R dose. In the range of doses which cause the "enteric" form of death, the animals were subjected to two doses at 500 and 600 R at intervals of 1.5, 3, 6, and 24 hr. Their survival rate was compared with that observed after single doses at 1100 R. Survival rates and results of bone marrow analyses under the various conditions of the experiments are graphed. The change in radioresistance of the organism, determined by sensitivity to repeated irradiation, was found to depend above all on the proliferative capacity of the bone marrow. Active restorative processes begin immediately after irradiation. They occur initially as a result of recovery of the vital capacity of the cell population in the bone marrow and intestines from sublethal doses, and later, as a result of regeneration. Changes in radioresistance following irradiation by large doses were of a similar nature. Comparison of the author's results with those obtained in experiments on neutron irradiation, in which no such changes in resistance were found, indicated a direct connection of the extent of cell damage with the magnitude of linear energy loss; at high values, cells are irreversibly damaged according to the "all-or-none" law. Special experiments have shown that the effectiveness of such radiation protection agents as cystaphos and mexamine is increased during the period of increased radioresistance. (ATD)

18177 CONDITIONED AVERSION TO SUCROSE IN RATS USING X-RAYS AS THE UNCONDITIONED STIMULUS. Smith, James C.; Birkle, Rose Ann (Florida State Univ., Tallahassee). Psychon. Sci., 5: 271-2(1966). (ORO-2903-25).

Rats that received 4 or 32% sucrose for 20 min prior to a 100 R x-ray exposure showed a marked aversion to saccharin flavored water in a postirradiation preference test. Controls receiving sham exposures or water prior to x rays preferred the sweetened solution. Results were interpreted as a conditioned aversion to sucrose with x rays as the motivating stimulus. (auth)

18178 ATOMIC ENERGY IN THE CONTROL OF INSECTS. Baccetti, Baccio (Univ., Siena, Italy). Georgofili, 9: 319-34 (1962). (In Italian).

The effect of ionizing radiation on the life span, fertility, and histologic structure of various species of insects is surveyed, and relative radiosensitivities of the species are compared. Success of the sterile male technique with different insect pests is outlined. Problems encountered in raising large numbers of insects for field studies are pointed out and discussed. Requirements that must be met for use of the sterile male technique on a large scale are listed and discussed. The author discusses, in particular, his own studies on Dacus oleae (olive fly) and Thaumetopoea pityocampa (pine tree pest). (TSS)

18179 THE INFLUENCE OF THYMECTOMY ON TRANSPLANTATION IMMUNITY IN THE SYRIAN HAMSTER (MESOCRICETUS AURATUS). Zabinski, J. (Inst. of Experimental Biology, Krakow). Folia Biol. (Krakow), 14: 131-50(1966).

Effects of thymectomy at various times after birth and/or x irradiation on skin graft rejection time, body weight, and leukocyte count were studied in golden hamsters. Thymectomy at 48 hr after birth in hamsters suppressed immunologic reactivity to xenogeneic grafts of mouse skin from the inbred R_{III} strain of mice in 67% of the recipients, and appearance of the immune reaction was delayed, to 9.2 days compared with 4.5 days in controls. Such thymectomy caused the thymic cachexia syndrome in 67%, leading to death in 81%. Thymectomy 3 to 10 days after birth did not diminish the immunologic reactivity to xenogeneic skin grafts, but thymic cachexia developed in 35%. In most animals with symptoms of thymic cachexia, thymectomy had been performed 3 to 5 days after birth. The later the operation, the less frequent were symptoms of thymic cachexia. Thymectomy in adult (2- to 3-month-old) hamsters never suppressed immunologic reactivity to xenogeneic skin grafts from inbred R_{III} mice, nor affected the numbers or composition of the white blood cells. After whole-body x irradiation of adult hamsters with 750 R, xenogeneic skin grafts were retained 1 to 2 days longer than in control animals. After thymectomy and whole-body irradiation with 750 R, xenogeneic skin grafts were retained for the same length of time as in hamsters that were only irradiated. Regeneration of the leukocytic system followed a similar course after thymectomy and in hamsters that were irradiated only. (BBB)

18180 INFLUENCE OF PRIOR IRRADIATION ON HOST SUSCEPTIBILITY TO INFECTION WITH THE ATTENUATED E STRAIN OF RICKETTSIA PROWAZEKII. Fabrikant, Irene B. College Park, Md., Univ. of Maryland, 1966. 153p.

Thesis.

Since the attenuated E strain of Rickettsia prowazekii induces solid long-lasting immunity against epidemic typhus in man, it has been considered for immunizing large populations under survival conditions following nuclear disaster. The present studies, therefore, investigated the effects of prior whole-body x radiation on hosts of graded innate susceptibility to typhus infection to assess whether radiation might lower resistance to rickettsial infection to such an extent that E strain might produce severe infection in the irradiated host instead of the mild or subclinical infection normally observed. The toxic, infective, and immunizing properties of virulent and avirulent typhus strains following intravenous or intraperitoneal inoculation were compared in Swiss Webster strain albino mice. The virulent Wilmington strain of Rickettsia moosera exhibited lethal toxic, lethal infective, and sublethal immunizing infective properties that were dose dependent. The virulent Breinl strain of Rickettsia prowazekii exhibited both lethal toxic and inapparent immunizing infective properties, but no lethal infection was induced. The avirulent E strain of Rickettsia prowazekii, however, induced lethal toxic effects only. It did not appear to multiply in the mouse as evidenced by approximately equal responses of mice immunized with live or killed preparations of E strain. Thus, any protection due to immunizing action was no greater than that afforded by comparable killed doses. Prior whole-body x radiation of mice in doses of less than 1 LD_{50} enhanced the lethal toxic action of E strain more than could be reasonably accounted for by chance variation in response. This effect occurred with increased radiation dose and increased interval between irradiation and inoculation with rickettsiae. The increased susceptibility of the irradiated animals to toxic inocula was evident and was not merely a response to the physical trauma of inoculation. Total-body irradiation failed to permit E strain rickettsiae to establish lethal infection even when relatively large doses of x radiation were employed (1 LD_{50} or more). The capacity of irradiated mice to develop anti-toxic immunity was reduced as the radiation dose was increased. The response of irradiated mice to inoculation with the virulent Breinl strain of Rickettsia prowazekii was similar to that with the E strain. Studies employing the serological response of normal pathogen-free guinea pigs to live and formalin-killed E strain suspensions suggested that E strain normally undergoes limited proliferation in this host. The infection, however, produced no overt signs of illness. The level of natural susceptibility of young guinea pigs to infection with E strain was more comparable to that of man, than was the susceptibility of the highly resistant white mouse. Irradiated (1 LD_{50}) guinea pigs inoculated with a high dose (10^{-2} dilution) or a limiting or threshold dose (10^{-6} dilution) of E strain failed to exhibit consistent body temperature patterns that could be interpreted as host response to radiation-enhanced infection. Inoculation with E strain failed to increase mortality of irradiated animals. Studies of the serological responses of irradiated guinea pigs infected with limiting dilutions of E strain yielded results most readily explained by a partial impairment of antibody formation in the face of somewhat enhanced proliferation. It was concluded that sublethal doses of whole-body x-irradiation may slightly enhance the susceptibility of guinea pigs to infection with the attenuated E strain. The resulting infectious process, however, remained at a subclinical level and did not alter the mortality of irradiated guinea pigs. The basis for attenuation of the E strain remains unknown; however, severe interference with host defense mechanisms by whole-body irradiation did not permit the E strain to undergo uncontrolled proliferation in the guinea pig that normally appears to permit a limited amount of proliferation to occur. (Dissertation Abstr.)

Radiation Effects on Plants

Refer also to abstracts 17955, 18036, and 18192.

18181 (COO-332-1) GENETIC AND BIOPHYSICAL STUDIES WITH SEEDS AND CELLS OF HIGHER PLANTS. Snyder, L. A. (Minnesota Univ., Minneapolis). Jan. 1967. Contract AT(11-1)-332. 17p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on the genetic analysis of mutants in barley induced by exposure of seeds to thermal neutrons at a flux of approximately $7.0 \times 10^9/cm^2/sec$ for 1, 2, 3, or 4 hr, exposure to doses of 3500R or 7,000R x radiation, or treatment of seeds with ethylmethanesulfonate (EMS) or triethylene melamine (TEM). Plants of the F_2 generation were analyzed to detect

linkage between a mutant and a suppressor. By the use of translocations and intercrosses among the suppressor mutants it was possible to identify additional loci at which suppressor mutations were induced. Implications of the genetic data are discussed. (C.H.)

18182 THE EFFECT OF SEED IONIZING IRRADIATION PRIOR TO SOWING ON THE MAIZE GROWTH AND PRODUCTIVITY. Ozol, A. M.; Peterson, E. K. (Inst. of Biology, Riga). Latv. PSR Zinat. Akad. Vestis. No. 11, 72-81(1966). (In Russian).

A direct relation between M_1 strain plant development pace and nonstimulating radiation doses was observed: the higher the radiation dose, the more retarded was plant development rate as compared to control plants. M_1 strain maize plants grown from seeds irradiated with fast neutrons or γ rays prior to sowing, as a rule, fell considerably behind control plants in height, foliage production, and ear weight. Unlike other plant forms, Melexberger-28 (M-28) plants were considerably more oppressed when irradiated with fast neutrons then when exposed to γ rays. High radiation doses (15 to 20 kR and 1.5 to 2.0 krad) considerably reduced M_1 plant resistance and produced a number of morphologic changes (snags, narrow-leaved, or albinotic forms); M-28 plants displayed the highest resistance. (auth)

18183 THE EFFECT OF STORING IRRADIATED PEAS AT A TEMPERATURE OF –196°C. Lebedeva, L. I.; Ermolaev, V. K.; Kerkis, Yu. Ya. (Inst. of Cytology and Genetics, Academy of Sciences, Siberian SSR. Inst. of Chemical Kinetics and Combustion, Academy of Sciences, Siberian SSR). Dokl. Akad. Nauk SSSR, 169: 1449-51(Aug. 21, 1966). (In Russian).

Two types of pea seeds containing 14.8 and 10.8% moisture were given an x ray dose of 10 kw at a dose rate of about 2000 R/min. Seedling survival 12 days after steeping the seed, the root, or stalk on the 12th day of growth, and the number of cells with chromosomal aberrations in the meristem were used as criteria of biological damage. Seedling survival reached a maximum at 30 minutes after storage at –196°C, and decreased gradually for longer storage times. The seed survival in the controls did not depend on the storage time at –196°C. Changes in root and stem length showed an analogous behavior, while no changes in seed development were observed in the controls on changing the time of storing the seeds in liquid nitrogen. The chromosomal aberrations decreased in the first hour of storage after irradiation, and then increased slowly with storage time. The storage effect disappeared at 0.8% seed moisture. No concrete mechanism for ion or free radical reactions at –196°C could be advanced. (TTT)

18184 EFFECTS OF IONIZING RADIATION AND FIRE ON GAYLUSSACIA BACCATA AND VACCINIUM VACILLANS. Brayton, R. D.; Woodwell, G. M. (Rutgers-The State Univ., New Brunswick, N. J.). Amer. J. Bot., 53: 816-20(Sept. 1966).

The hypothesis that the differential effects of both fire and ionizing radiation on these 2 shrubs are related to their capacity for vegetative propagation was tested. Chronic γ irradiation caused a similar pattern of damage and regeneration in these 2 shrubs. At 33 R/day shoot growth was initiated principally from aerial shoots. At higher radiation exposures a progressively higher proportion of the regeneration was from rhizomes. Aerial exposures of 105 R/day eliminated Gaylussacia. Vaccinium at this exposure produced sprouts but only from rhizomes 1.0 cm or more deep. At aerial exposures of 180 R/day sprouts occurred only from rhizomes 2 cm or more deep. Measurements of radiation exposures of various depths in soil indicated that sprouting of Vaccinium shoots and rhizomes did not occur when rhizomes were receiving more than 65-70 R/day. Gaylussacia was more sensitive; there was no sprouting from above-ground stems receiving more than 45-50 R/day and there were no sprouts from basal buds or rhizomes in areas receiving aerial exposures above 65 R/day. Fire had parallel effects to those of irradiation on survival of natural populations of Gaylussacia and Vaccinium. Vaccinium was substantially more resistant to both. The differences in survival were due to differences in regenerative capacity; buds of Vaccinium were more resistant to damage, occurred at greater depths in the soil, and were better protected from both radiation and heat. This pattern of radiation and fire resistance confirmed that in plants radiation resistance is related to ecological hardiness. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 17955, 18022, and 18025.

18185 HIT-THEORY MODEL FOR RADIOINDUCTION OF PROPHAGE IN LYSOGENIC MICROORGANISMS. Noack, D. (Institut fuer Mikrobiologie und Experimentelle Therapie, Jena, Ger.). Biophysik, 3: 118-22(1966). (In German).

A hit-theory model for radioinduction of prophage in lysogenic microorganisms is described and its kinetics are analyzed as a function of radiation dose. It is pointed out under which simplifying hypotheses the three principal transition probabilities relative to colony formation, prophage induction and inactivation can be determined in their dose dependence and interpreted in terms of the hit theory. (tr-auth)

18186 ULTRAVIOLET INACTIVATION AND PHOTOREACTIVATION OF CHLOROPLAST DEVELOPMENT IN EUGLENA. Schiff, Jerome A.; Epstein, H. T.; Lyman, Harvard (Brandeis Univ., Waltham, Mass.). pp 289-92 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

To find out whether the light induction of chloroplast development in Euglena was related to photoreactivation (PR), an action spectrum was measured for PR of chloroplast formation. The effectiveness spectrum has a broad peak in the near uv, similar to PR in other systems such as Escherichia coli. Green or red light was completely ineffective. This separates PR clearly from the light induction of chloroplast development since this action spectrum has peaks in the blue and red regions of the spectrum, indicating that the chromophores for PR and chloroplast induction are different. The differences in these action spectra made it possible to induce chloroplast formation in uv-treated cells without bringing about concomitant photoreactivation. If dark-grown cells given a uv dose sufficient to yield almost 100% albino colonies were exposed to red light, the transformation of protochlorophyll to chlorophyll still occurred normally. This showed that uv does not act at this early stage of chloroplast formation. Chloroplast and chlorophyll production was followed by fluorescence microscopy at various times after uv irradiation. Chloroplasts and chlorophyll developed normally in uv-irradiated cells. When aliquots of these greened cells were plated under nonphotoreactivating conditions, 100% albino colonies were obtained. The control cells were still capable of being photoreactivated at the end of the experimental period. This showed that the effect of uv is not on chloroplast development from precursors in the dark-grown cells, but that uv inhibits the replication of chloroplasts, or the sites that make them, at cell division. It is inferred that there are heritable nucleoprotein entities in the cells which control chloroplast development. (BBB)

18187 MUTATION TO ULTRAVIOLET RESISTANCE AND FILAMENT FORMATION IN BACTERIA. Kalle, G. P.; Agrawal, A. K.; Sivasubramanian, P. P. (Atomic Energy Establishment, Bombay). Indian J. Genet. Plant Breed., 26A: 431-40(1966).

A uv-resistant mutant (uv-r-43) was isolated from a thymine-requiring strain of Escherichia coli (B-3). This mutant resembled its parent strain in the capacity to form filaments and to recover from initial growth inhibition by uv during the postirradiation period. It was therefore characterized as syn^+ fil^+ uv-r. Ultraviolet survival curves of this newly isolated strain suggested that it was as resistant as B/r, a uv-resistant mutant of E. coli B. Resistance in uv-r-43 was found to be dependent on the preirradiation growth medium and was expressed only when the mutant was grown in synthetic, not in nutrient, medium. It is postulated that the mutational site for uv-r-43 is distinct from fil, syn, or thy markers, since resistance in this mutant is independent of mutation at any of these loci. Both ur-r-43 and B/r are independently derived by mutation at two different loci on E. coli chromosome. (TSS)

18188 PHOTOREACTIVATION IN VIRUSES AND PLANTS. Kleczkowski, A. (Rothamsted Experimental Station, Harpenden, Eng.). pp 293-5 of Progress in Photobiology. Christensen, B. Chr.; Buchmann, B. (eds.). Amsterdam, Elsevier, 1961.

The uv inactivation and photoreactivation of a virus and its nucleic acid was investigated quantitatively in tobacco mosaic virus (TMV). It is one of a few plant viruses whose inactivation by uv can not be reversed by photoreactivation, but inactivation of its isolated infectious nucleic acid can be partially reversed by photoreactivation. The nucleic acid in the intact virus is very much more resistant to uv than it is when isolated. When the isolated nucleic acid is uv-irradiated, about half of absorbed radiation energy causes the kind of damage that is reversible by photoreactivation and the other half causes damage that is not reversible. When intact virus is irradiated, inactivation of nucleic acid by radiation energy absorbed by it progresses at a rate that is roughly about $1/_{10}$th of that of free nucleic acid, and the kind of damage that is reversible by photoreactivation does not occur. The probable reason for the greater resistance to uv of the nucleic acid in the intact virus is that the bonding between the nucleic acid and the protein reinforces the structure of components of nucleic acid. The way in which nucleic acids are bonded with protein in different viruses or in different other organisms probably influences the degree to which they can be photoreactivated after uv irradiation. Susceptibility of capacity to uv varies considerably not only between dif-

ferent species and varieties of plants, but between plants of the same variety and between leaves of the same plant, and it depends on such factors as the age of the plant, the season of the year, and temperature and illumination for a short time before irradiation. (BBB)

18189 EFFECT OF LASER ENERGY RADIATION ON BACTERIA. McGuff, Paul E.; Bell, Emily J. (Univ. of Cincinnati). Med. Biol. Illus., 16: 191-4(July 1966).

Four different lasers, at different magnitudes of focus and energy level, were used to study laser effects in 4 types of bacteria, 2 Gram-negative, and 2 Gram-positive species: Pseudomonas aeruginosa, Proteus vulgaris, Staphylococcus aureus, and Bacillus subtilis. Culture plates were exposed after 3-hr growth of the organisms to various joule energies and modalities of laser energy radiation. Ruby and neodymium solid state lasers, as well as a helium-neon (continuous wave) gas laser, were used. No lethal effect of laser energy on bacterial growth on solid medium could be detected. This negative finding may perhaps have resulted from rapid overgrowth by viable cells of varying millimeter-sized, laser areas on a semisolid medium. With P. aeruginosa pigment production was inhibited by a 0.5 mw focussed, continuous wave, helium-neon gas laser after 5-hr exposure. But pigment production over the entire plate was enhanced markedly by one burst of 10 Mw Q-switched ruby laser energy, and a local increase in pigmentation was noted after exposure to one burst at 40 Mw. An effect of color absorbants was also noted. The unfocussed neodymium laser, at 100-J energy level, caused an effect on pigment production only in the presence of India ink, indicating that the presence of a dye augments the absorption of laser energy by microorganisms. An absorbant, however, was not necessary for the enhanced pigment production by P. aeruginosa as observed in this study after Q-switched ruby laser radiation. (BBB)

18190 THE RESISTANCES OF SPORES OF THE GENUS BACILLUS TO PHENOL, HEAT, AND RADIATION. Briggs, A. (Univ. of London). J. Appl. Bacteriol., 29: 490-504(Dec. 1966).

Resistance of spores of 6 species of Bacillus to 5% (w/v) of phenol at 37°, heat, and γ radiation was determined. Two, and with heat treatment 3, different shapes of log survivor-time curves were observed with each lethal agent. The curves relating log % survivors of the different strains to radiation dose for B. cereus, B. stearothermophilus, and B. megaterium exhibited a pronounced shoulder extending to about 0.2, 0.5, and 0.6 Mrad, respectively, whereafter a linear relation was observed. The other spores exhibited a linear relation over the whole dose range. B. stearothermophilus, B. licheniformis, and B. subtilis were resistant to radiation, all 3 having a D value of 0.22 Mrad. Only B. stearothermophilus was heat resistant having a D value of 22.6 min at 115°. When the relative order of resistance to each agent was considered, with the exception of B. stearothermophilus, the spores showed little evidence of any relation between their resistances to phenol, heat, and radiation. (BBB)

18191 QUANTITATIVE ANALYSIS OF REACTIONS OF THE NUCLEAR APPARATUS OF YEAST CELLS TO RADIATION. Fofanova, K. A. (Inst. of Medical Radiology, Obninsk, USSR). Zh. Obshch. Biol., 28: 116-21(Jan.-Feb. 1967). (In Russian).

Effects of x rays in doses of 37, 77, and 117 kR on nuclei of Saccharomyces vini were studied during mitosis and budding. Radiation damage was evaluated according to the relation between cell forms and structural changes in the nuclei during mitosis. It was shown that the pattern of mitosis and dynamics of transition to budding were affected by irradiation, the latter effect being dose-dependent. Each of the doses disturbed the mechanism of bud separation, resulting in the appearance of colonies of 3 to 6 cells after 5 to 6 hrs of incubation. Morphological effects were noted following nuclear division and were dependent on incubation time in the nutrient medium. (H.G.D.)

18192 RADIOBIOLOGY: EFFECT OF X RAYS ON THE FORMATION OF TUMORS PROVOKED ON TISSUES OF JERUSALEM ARTICHOKE BY AGROBACTERIUM TUMEFACIENS. Jonard, Robert; Landre-Ruch, Claudie (Faculte des Sciences, Paris). Compt. Rend., Ser. D., 263: 1517-20(Nov. 14, 1966). (In French).

The tumorigenic activity of Agrobacterium tumefaciens is inhibited in x-irradiated (2000 to 3000 R) artichoke tissues when irradiation is performed prior to inoculation of the etiologic agent. (tr-auth)

18193 SINGLE BURST ANALYSIS OF THE MECHANISM OF APPEARANCE OF UV INDUCED MUTATIONS IN EXTRACELLULAR BACTERIOPHAGE. Kriviskii, A. S. (Inst. of Molecular Biology, Moscow). pp 75-85 of Physiology of Gene and Mutation Expression. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966.

It has been shown that the mutation rate of E. coli CK bacteriophage can be induced to increase 300 fold after exposure to x or γ radiation in vitro. Alpha irradiation also induces an increase in rate, but to a lesser extent. An attempt was made to determine whether mutations induced by irradiation of extracellular phage arise prior to or during replication of the phage DNA. Phage were irradiated with a 250 erg/mm^3 dose of uv. After infection (multiplicity <0.03) plaque mutants appeared in 66 of the 1821 bursts (single-burst technique). Of these 53 were mixtures with wild type and 13 pure mutant. Some of these may have represented bursts from more than one infected cell, but at least some of the mixed bursts represented single bursts. The majority contained an excess of wild type plaques. It is suggested that some of the mutants arise in extracellular phage (pure mutant clones) while others are delayed until replication in the host (mixed clones with an excess of wild type). (M.M.B.)

18194 INDUCTION OF THE PROPHAGE OF E. COLI K 12 (λ) BY UV-IRRADIATION AT DIFFERENT STATES OF CULTIVATION. Noack, D. (Inst. of Microbiology, Jena, Ger.). pp 247 of Physiology of Gene and Mutation Expression. Kohoutova, Margita; Hubacek, J. (eds.). Prague, Czechoslovak Academy of Sciences, 1966.

Radiosensitivity of Escherichia coli K 12(λ), as measured by prophage induction and by cell viability, was investigated. The effect of physiological stage on radiosensitivity was studied by irradiation at different stages in growth. The data are consistent with the conclusion that there is an interaction between prophage induction and bacteriocidal effects of uv radiation. (M.M.B.)

18195 REDUCTION OF HEAT AND RADIATION RESISTANCE OF BACILLUS CEREUS SPORES BY INITIATING GERMINATION. Farkas, J.; Kiss, I.; Andrassy, Eva (Central Food Research Inst., Budapest). Acta Microbiol., Acad. Sci. Hung., 13: 35-46(1966).

Methods for decreasing thermal and radiation resistance of B. cereus spores are outlined. The germination activating effect of heat at 60°C was evident after 4 min and increased proportionally in relation to incubation time. Germinating spores became less refractive as resistance to heat and radiation were decreased. In a pea extract medium and in a medium of green peas placed in a liquor containing salts and sugar, the rate and frequency of spore germination was increased when adenosine and L-alanine were added. The effect of additives or germinants on induction of spore germination was apparent within a few minutes after incubation at 30°C. Reduction of heat resistance and increase in radiation sensitivity of spore populations were in agreement with phase microscopic observations of the cells. The combined use of heat activation and germinants increased heat and radiation sensitivity of spores at concentration of 10^8 to 10^9 cells/ml and in the medium used for spore production. The use of heat activation and germinants for production of heat and radiation sensitive spores in processed foods prior to radiosterilization is discussed. (TSS)

18196 ON THE NATURE OF THE INDUCIBLE ANTIBACTERIAL AGENT OF E. COLI 15. Mennigmann, Horst-Dieter (Johann Wolfgang Goethe-Univ., Frankfurt am Main). Zentralbl. Bakteriol. Parasitenk. Infektionskrankh. Hyg. Abt. 1, 196: 207-10(1965).

Various observations indicating the induction of a defective phage of Escherichia coli by uv are discussed. The question remains open whether at the same time the production of a bacteriocine-like substance is also induced by uv. In addition, some observations are cited regarding this induction and production and the interaction between this phage and the cells sensitive to it. (TSS)

18197 ON TWO TYPES OF INTERACTION OF ROUS SARCOMA VIRUS (CARR STRAIN) WITH MAMMALIAN CELLS IN VIVO. Kryukova, I. N. (Gamaleya Inst. of Epidermiology and Microbiology, Moscow). Acta Virol. (Prague) Engl. Ed., 10: 440-9(Sept. 1966).

Radiation experiments, employing both uv and x rays, were used in attempts to unmask or activate Rous sarcoma virus (RSV) in mammalian tissues. Mice of various lines, Wistar rats, and Chinchilla rabbits were inoculated with 30% RSV homogenates after the sarcoma had been passaged in White Leghorn chicks. By use of the immunofluorescence technique, fluorescent cells containing virus antigen were observed in cyst walls and internal organs of rats, rabbits, and mice and in tumors in rabbits in the absence of mature virus. The fluorescence was probably due to the presence of virus in an incomplete form. In the sera from diseased rats and mice, antibodies against RSV were absent. In rabbits, RSV antibodies appeared in serum at the time of disintegration of the tumors. In rats with hemorrhagic cysts, the state of actively acquired immunological tolerance to antigens of the viral coat was induced in some instances. In rabbits with RSV tumors, immunological tolerance did not develop. By uv or x irradiation of rabbit tumors it was possible to activate RSV. Irradiation of cyst walls, liver and tumors of rats caused no perceptible activation of RSV. It is concluded that the interaction of

RSV with cells of rats and probably of mice is more intense than with cells of rabbits. (BBB)

18198 HYGIENIC-MICROBIOLOGICAL PROBLEMS IN THE USE OF IONIZING RADIATION. Ritzerfeld, W. (Univ., Muenster, Ger.). Zentralbl. Bakteriol. Parasitenk., Abt. I. Orig., 198: 248-53(1965). (In German).

Effects of irradiation on staphylococci, Escherichia coli, Pseudomonas aeruginosa, and Bacillus subtilis were studied to ascertain the possibility of using this method to sterilize Ra needles. The bacteria were noticeably injured only after prolonged contact with the needles. Growth of the staphylococci ceased after 32 hr contact, while P. aeruginosa and E. coli were still capable of growth after this time interval. Their growth ceased only after 64 hr of exposure to the radiation from the Ra needle. B. subtilis ceased growth after 128-hr exposure. The contact time required to definitely injure the bacteria studied was generally longer than the time between treatment of patients at this clinic. In order to test the effects of ^{60}Co irradiation as a sterilizing agent, cultures of Mycobacterium smegmatis and M. phlei were irradiated with doses from 12,060 to 289,440 R. Both organisms showed essentially the same radiosensitivity. After 36,000 R oxygen consumption by M. smegmatis was reduced 20%, and after 96,500 R, O_2 consumption was ~60% reduced. After ~300,000 R, the reduction was ~60%. These results indicated that practical problems of radiation sterilization confront the microbiologist in order to meet clinical hygienic requirements. (BBB)

Radiosterilization and Radiopreservation

Refer also to abstracts 18195 and 18198.

18199 TESTS FOR CONTROL OF THE PINE PROCESSIONARY BY THE USE OF IONIZING RADIATION. Baccetti, Baccio; Zocchi, Rudolfo (Univ., Siena, Italy). Redia (Florence), 47: 161-7 (Oct. 1962). (In Italian).

The possibility of controlling or eradicating Thaumetopoea pityocampa (pine pest) by the radiation-sterilized male technique was investigated. Pupae that were 15 days old were exposed to 4000, 6000, 8000, or 12,000 R of ^{60}Co γ radiation. The highest dose was lethal for 99% of the pupae. About 25% of pupae treated with 8000 R dose developed into adults; at doses of 6000 and 4000 R, >50% developed into adults. There was no difference in incidence of radio-induced lethality in males and females. In fertility experiments males were irradiated with 4000 or 6000 R and mated with nonirradiated females; similarly irradiated females were mated with normal males. When 32 of the 4000-R irradiated females were mated with normal males, a total of 60 eggs was obtained as compared with an average of 200 produced by normal females mated with normal males. When males irradiated with 4000 R were mated in 1/1 ratio (irradiated male/nonirradiated male) with normal females an average of only 8 eggs per female was produced; at a 2/1 or 3/1 ratio no eggs were produced. Although the results demonstrate the possible use of the radiation-sterilized male technique for eradication of this insect, the problems of raising and feeding large numbers of larvae were deemed formidable. (TSS)

18200 EFFECT OF ULTRAVIOLET RAYS IN THE REFRIGERATOR. Ishihara, Fusao; Hatanaka, Midori (Kagawa Nutrition Coll., Japan). Eiyo To Shokuryo, 18: 444-8(Mar. 1966). (In Japanese).

Effects of ultraviolet radiation in the refrigerator were investigated. Two refrigerators of the same type were prepared; one irradiated by a 2-watt lamp of ultraviolet rays inside and the other nonirradiated as a control. Suspensions of bacilli such as Escherichia coli, Enteritis vibrio parahemolitics, Enteritis Gärtner, Staphylococcus, and hay were left in the two refrigerators. After a certain storage time the number of colonies was examined. It was found that in the irradiated samples it was reduced $^1/_6$ to $^1/_{300}$, possibly influenced by ultraviolet rays. To study a preservative value of ultraviolet rays acting against putrefaction, pH, NH_3 production, protein precipitation, and the number of all bacilli per 1 g were compared. The results showed the progress of putrefaction in the irradiated samples was 5 to 6 days slower than in the non-irradiated control, and that the number of bacilli in the air in the refrigerator irradiated decreased to $^1/_6$. The air contained only a small amount of ozone. (auth)

18201 EFFECTS OF GAMMA RADIATION ON THE GRAIN MITE, ACARUS SIRO. Burkholder, Wendell E. (Univ. of Wisconsin, Madison); Tilton, Elvin W.; Cogburn, Robert R. J. Econ. Entomol., 59: 976-80(Aug. 1966).

As a part of a study on the effects of ionizing radiation on induced sterility and mortality of stored-product pests, Acarus siro eggs, larvae, and adults were subjected to γ radiation from a ^{60}Co source. Doses of 13.2, 17.5, 22, 45, and 100 krad were used. Eggs hatched at all dose levels. However, no adults developed at the 100-krad dose. Pairings of adults developed from eggs treated at the 25- and 45-krad doses produced no F_1 adults. Production of F_1 and F_2 adults was successful after 13.2 and 17.5-krad doses. No adults developed from larvae irradiated with 45 or 100 krad, but adults did develop at doses of 25 krad and lower. Only those irradiated at the 17.5-krad dosage and below, however, produced F_1 adults. F_2 adults were produced only when the original larvae were irradiated at 13.2 krad. Irradiated hypopi developed to the adult stage only when the dose was 45 krad or lower. At the 25-krad dose and lower, they produced F_1 adults, but F_2 adults were produced only at 17.5 krad. Production of F_1 and F_2 adults from irradiated adults was limited to 25 krad and below. The survival time of mites treated as hypopi was shorter at all dose levels. In general, the higher the dosage the shorter the survival time. Untreated adults and those at all treatment levels had similar survival times, except that survival time was much shorter after 100 krad. (BBB)

18202 RADIATION PASTEURIZATION OF BROILER CHICKEN CARCASSES. Rhodes, D. N. (Meat Research Inst., Cambridge, Eng.). Brit. Poultry Sci., 6: 265-71(July 1965).

Irradiation of chicken meat with 2-MeV electrons, or of eviscerated whole carcasses with γ radiation, revealed that doses below 0.25 Mrad have no detectable effect upon the acceptability of the meat after cooking. The dose of 0.25 Mrad destroyed sufficient spoilage bacteria to extend the storage life (measured to the eventual onset of bacterial spoilage) by 3-fold at 1°C. During long-term chill storage, however, the quality of the meat declined rapidly, probably on account of changes inherent in the muscle. These considerations eliminate the possibility of long-term chill storage of pasteurized poultry so that studies were undertaken to define a process aimed at the direct marketing of broiler carcasses without freezing. For this purpose a max of 6 days was deemed necessary for distribution and retailing, with 1 further day to allow for the consumer holding the carcass before consumption. It was found that irradiation of standard broiler carcasses within 24 hr of slaughter with a dose of 0.15 Mrad of γ radiation was sufficient to give a shelf life of more than 6 days at 5°C, followed by 1 day at 15°C. The carcasses treated and stored in air remained unchanged in appearance and odor. After cooking, treated and stored carcasses were indistinguishable, when tasted in blind comparison tests, from unirradiated material held at –20°C for the same time. (BBB)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstract 18308.

18203 (IDO-17218) ANNUAL PROGRESS REPORT ON REACTOR FUELS AND MATERIALS DEVELOPMENT FOR FY 1966. Francis, W. C.; Moen, R. A. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Nov. 1966. Contract AT(10-1)-205. 160p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress is reported on developments on U–Al intermetallic fuel systems, on compatibility of this material with matrix and cladding materials, and on new developments in cladding and coating materials. The results of dynamic corrosion tests are reported on several Al alloys developed for elevated temperature operation. This work also includes extensive investigation of electroless Ni coatings. The stability of dispersion fuels is discussed in considerable detail including the important contribution of initial porosity in restricting the uniform swelling resulting from the production of solid fission products. Accelerated swelling thresholds were measured by means of post-irradiation blister tests. The results of compression and gas release measurements on Be irradiated at reactor ambient and high temperatures are reported and compared with fractography studies. Diffusion coefficients were determined for He gas in Be. Fatigue measurements on Types SA302B and SA212B steels are reported, and the status of construction of an in-pile fatigue test facility is described. Work reported also includes developments in fabrication techniques, modifications to the microprobe for handling irradiated specimens, and failure analysis. (auth)

18204 (NP-16427) BIBLIOGRAPHY ON THE HIGH-TEMPERATURE CHEMISTRY AND PHYSICS OF MATERIALS IN THE CONDENSED STATE. Volume 1966, Number 3, July–September 1966. Diamond, J. J. (ed.) (National Bureau of Standards, Washington, D. C.). 65p. NBS, Washington, D. C. Free.

Titles are listed of U. S. and foreign research papers published 1965 to 1966 which deal with high-temperature chemistry and physics of inorganic materials. Included are titles of articles describing methods for attaining temperatures above 1500°C, measurement and control devices, properties of metallic, nonmetallic, and mixed materials which melt above 1500°C. Phase equilibria titles are given for 128 inorganic complexes. (P.G.C.)

18205 (TRG-Inf. Ser.-312(Suppl.1)) BIBLIOGRAPHY ON LIQUID METALS, 1964–1965. Fenney, S. H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group). Nov. 1966. 79p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 10s.

A bibliography comprising of unclassified references to the literature on liquid metals, particularly sodium and sodium/potassium is presented. It is a continuation of TRG Information Series 312(R) and covers a further two years adding 649 references. (auth)

Corrosion and Erosion

Refer also to abstracts 18227, 18238, 18256, 18258, 18261, 18277, and 18301.

18206 (COO-1319-48) EFFECTS OF SURFACE PREPARATION IN THE STRESS CORROSION CRACKING OF STAINLESS STEEL. Cochran, R. W.; Staehle, R. W. (Ohio State Univ. Research Foundation, Columbus). Oct. 1966. Contract AT(11-1)-1319. 117p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of surface preparation on the incidence of stress corrosion cracking of Type-310 stainless steel was investigated. Wire specimens were used and exposed to boiling $MgCl_2$. Surfaces were prepared by mechanical polishing at three levels of roughness, chemical polishing, vacuum annealing, and electrochemical polishing. A wire range of mean-times-to-cracking was noted. Mean times differed by about a factor of five. Distribution of cracking times also varied about the mean values. Mechanically polished specimens cracked in shorter times than those chemically polished or vacuum annealed. The data were rationalized in the terms of probability of forming chemically active slip steps. (auth)

18207 (EURAEC-1581) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Final Report No. 1, June 16, 1962–October 31, 1965. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)). Dec. 13, 1965. Contract 089-62-7 RD B. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Results of research to determine the influence of the surface state on steel corrosion in high temperature water and steam are presented. The corrosion tests in water were carried out under static conditions using autoclaves and H_2 diffusion method, and under dynamic conditions at rates varying from 2 to 18 m/sec. The tests in superheated steam were performed under static conditions alone. The temperature range examined was 200 to 350°C for water, and 250 to 600°C for superheated steam. Various grades of stainless steel and one grade of boilerplate steel were examined. (auth)

18208 (MSAR-67-17) EFFECT OF HIGH TEMPERATURE SODIUM ON AUSTENITIC AND FERRITIC STEELS. MECHANICAL PROPERTIES OF MATERIALS. Quarterly Progress Report, October–December 1966. (MSA Research Corp., Evans City, Pa.). Feb. 1966. Contract AT(11-1)-765. 22p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary of work completed and contemplated to determine effects of dynamic Na systems upon properties of austenitic and ferritic stainless steels is given. (P.G.C.)

18209 (SAN-595-2) POTASSIUM TURBINE EROSION. Linhardt, Hans D.; Smisek, R. F.; Cheslak, F. R. (Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.). Dec. 15, 1966. Contract AT(04-3)-595. 59p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results directed towards the design, fabrication, and testing of a supersonic turbine within the environment of an externally heated, forced convection, boiling-condensing, pressurized closed-loop K facility are summarized. The unit used was a supersonic turbine run for 96 continuous hours at an average shaft speed of 17,800 rpm with average turbine stagnation conditions of 1250° F and 5.6 psia and theoretical nozzle exit vapor quality of x = 0.85. The test turbine wheel, which was made of TZM material, had four different blade geometries with blade angle varying between 25 and 40 degrees. The most prominent feature evident on inspection of the turbine wheel was an erosion groove starting at the leading edge near the root of each blade and then continuing in a radial direction to the blade tip immediately behind the leading edge on the convex side of the blade. In addition, two of the three partial admission turbine nozzles experienced a large amount of what appeared to be corrosion with large deposits visible on the nozzle walls. Due to flow separation, it is believed that a puddle of liquid K accumulated downstream of the corroded nozzle area, from which large liquid K droplets were shed. The impingement of these secondary droplets upon the turbine wheel would explain the erosion groove on each blade. The small amount of erosion visible on the concave and convex side of the blades near the leading edge is attributed to the impingement of primary or freestream potassium droplets. It is recommended that nozzle corrosion be eliminated by redesign of the nozzles and a more stringent control of the oxygen level during loop operation. (P.C.H.)

18210 (WAPD-TM-543) THE CORROSION AND HYDROGEN ABSORPTION CHARACTERISTICS OF ZIRCONIUM ALLOYS CONTAINING IRON, CHROMIUM, TIN, AND NIOBIUM. Kass, Stanley (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1967. Contract AT(11-1)-Gen-14. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The corrosion and hydrogen absorption properties of Zr base alloys containing 0.5 or 1.0% Fe, 0.5 or 1.0% Cr, 0 or 0.5% Sn, and 0 or 0.5 % Nb in high temperature water and steam have been studied. All alloys containing Nb exhibited higher strength characteristics than the corresponding Nb-free alloys and were stronger than both Zircaloys-2 and -4. The alloy containing 0.5% Fe, 1.0% Cr, 0.5% Sn and 0.5% Nb exhibited a low corrosion rate, approximately equal to that of the Zircaloys and at the same time absorbed very small amounts of H_2, approximately half as much as Zircaloy-4, during aqueous corrosion exposure. (auth)

18211 CORROSION PROBLEMS BY HOT GASES IN NUCLEAR REACTORS. Darras, M. R. (CEN, Saclay, France). Energ. Nucl. (Paris), 8: 540-53(Dec. 1966). (In French).

After a general discussion of dry oxidation of metals and alloys, the chemical behavior of the most important nuclear materials in the presence of CO_2 and other gases in a temperature range between 400 and 800°C was examined. (auth)

18212 PROTECTION OF NIOBIUM FROM OXIDATION BY A $NbSi_2$ COATING IMPREGNATED WITH SnAl. Lux, B.; Stecher, P.; Perlhefter, N. (Institut Battelle, Geneva). Ann. Mines., 802-21(Oct.-Nov. 1966). (In French).

A coating system was developed to protect Nb against oxidation at temperatures above 1000°C. General properties required of a coating system and, in particular, the significance of self-healing are discussed. A description is given of the structure and of the mode of action of the described coating, which consists, in principle, of a framework composed of an intermetallic phase, into the pores of which a liquid, oxidation-resistant phase is incorporated. The investigations of its properties included a study of the oxidation behavior of the different components of the coating and a search for possibilities of altering this behavior. Also described is the production process of the coating, which consists of a diffusion treatment of Nb specimens in a Sn–Al–Si bath, the surface of the specimens having been prepared beforehand. The modifications which the coating undergoes at elevated temperatures are ascribable to diffusion phenomena that subsequently lead to the destruction of the coating. Results obtained with static or cyclic tests are presented and discussed. (BBB)

18213 REACTION OF TANTALUM WITH NITROGEN AND AIR. Gavrilyuk, M. I.; Ershova, V. T.; Konstantinov, V. A. Metalloved. Term. Obrabotka Metal., No. 12, 37-40(Dec. 1966). (In Russian).

Vacuum arc-melted ingots of 99.51%-pure tantalum were homogenized and rolled into 1-mm-thick sheets, which were annealed in a vacuum of 1×10^{-4} mm Hg, and then held in a nitrogen atmosphere at 800 to 1200°C for 1.5 to 10 hr or in air at 300 to 600°C for 1 to 15 hr. The depth of nitrogen penetration into tantalum was found to increase with increasing temperature and duration of the contact of tantalum with nitrogen. A particularly sharp increase in the penetration rate was observed at temperatures above 900°C. In the reaction of tantalum with air, the increase in metal microhardness and in the depth of air penetration followed a similar pattern. However, the reaction of tantalum with air began at 300°C, and the increase in the microhardness of tantalum, in this case, is attributed to the air oxygen. The nitrogen-contaminated surface layer consisted of four zones: a very thin outer zone of TaN followed by a zone consisting of TaN_2, a zone with a tetragonal lattice (a = 3.314 kX, c = 3.3715 kX, c/a = 1.0175), and a zone with a bcc structure. Vacuum annealing of contaminated tantalum at temperatures up to 1600°C brought about a diffusion of nitrogen and oxygen from the surface deep into the metal and metal contamination in the entire volume. The removal of nitrogen and oxygen from tantalum in vacuum began at 1800 to 2000°C. Nitrogen and oxygen in the solid solution strongly inhibited the grain growth of tantalum. (ATD)

18214 9e COLLOQUE DE METALLURGIE. ETUDE SUR LA CORROSION ET LA PROTECTION DU ZIRCONIUM ET DE SES ALLIAGES, SACLAY LES 24 ET 25 JUIN 1965. (9th Colloquium on Metallurgy. Study of Corrosion and Protection of Zirconium and Its Alloys, Saclay, June 24–25, 1965). Salesse, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. 195p. (CONF-650677).

The 13 papers presented at the 9th colloquium on metallurgy on the corrosion and protection of Zr and its alloys are compiled together with the discussions following each paper. Individual abstracts for each paper are presented. (J.S.R.)

For abstracts of individual papers see: 18215–18222, 18250, and 18290–18293.

18215 FUNDAMENTAL ASPECTS OF ZIRCONIUM OXIDATION PHENOMENA WITH PURE OXYGEN. Debuigne, J.; Guerlet, J.-P.; Lehr, P. (CNRS, Vitry-sur-Seine, France). pp 9-26 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Oxidation of zirconium in pure oxygen and in a constantly renewed CO_2-atmosphere was studied and the kinetics of these phenomena are reviewed. Diffusion coefficients of oxygen in the metal at various temperatures were determined using zirconium of different purities and oxidizing in pure oxygen. Diffusion coefficients of O_2 in monoclinic ZrO_2 were also determined at 600 to 1200°C, dealing with the oxidation of α-zirconium of compact hexagonal structure and stable below 870°C and β-zirconium with a cubic centered structure. Oxidation phenomenon was found to be controlled by the anionic diffusion of O_2 through the surface film of ZrO_2 and also by diffusion of O_2 in the underlying metal. (P.C.S.)

18216 OXIDATION OF ZIRCONIUM AND CERTAIN OF ITS ALLOYS IN CARBON DIOXIDE. Guerlet, J.-P.; Debuigne, J.; Lehr, P. (CNRS, Vitry-sur-Seine, France). pp 27-38 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

The chemical reactions considered in this problem were: (1) $Zr + 2\,CO_2 \rightleftharpoons ZrO_2 + 2\,CO$; (2) $Zr + 2\,CO \rightleftharpoons ZrO_2 + 2\,C$; and (3) $Zr + C \rightleftharpoons ZrC$. Diffusion coefficients of O_2 in Zr and through ZrO_2 were determined at 600 to 850°C. An important factor in these oxidation problems was the effective composition of the atmosphere as expressed by the ratio P_{CO_2}/P_{CO}, and when the work is performed under a constantly renewed CO_2 atmosphere this factor was dependent on the flow rate of the gas. Main factors involved in the choice of additives, with a view to improving the resistance of Zr to oxidation are discussed. The results obtained on certain alloys and the influence of the structural state of the alloy are given. (P.C.S.)

18217 ZIRCONIUM ALLOYS RESISTANT TO OXIDATION IN CARBON DIOXIDE AT HIGH TEMPERATURE. Baque, P.; Darras, R.; Loriers, H. (CEN, Saclay, France). pp 39-52 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Corrosion of Zr and its alloys in CO_2 was studied. The two processes involved were: the setting up of a layer of monoclinic zirconia, through which O_2 diffuses by migration of anionic vacancies, and the diffusion of O_2 in the subjacent metal, giving rise to an insertion solution. Zr–Cu alloys showed prolonged parabolic or cubic oxidation kinetics up to at least 700°C, whereas after a certain time unalloyed Zr was subject to breakaway which led to linear kinetics. The presence of Zr_2Cu-precipitates seemed to play an important part in the improved behavior of these alloys. At the same time, the apparent diffusion coefficient of O_2 in the oxide layer formed decreased as the Cu concentration of the Zr increased; in addition the apparent diffusion coefficient of O_2 in the alloy, although little changed at 600°C, decreased at 700°C when the Cu content rose to 2.5%. Zr–Cu alloys, particularly that with 2.5% Cu, showed possibilities as cladding material for the fuel elements of heavy water–carbon dioxide type reactors, and also perhaps as structural material. (auth)

18218 CORROSION RESISTANCE OF NEW ZIRCONIUM ALLOYS. Kruys, P. (EURATOM, Brussels). pp 53-61 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

The corrosion behavior of zirconium ternary alloys of the type Zr–Nb–Sn and Zr–Cr–Fe in water and steam is reported. The $Zr-Nb_3-Sn_1$ alloy, annealed at 575°C, had a corrosion resistance of the same order of magnitude as Zircaloy-2, however, its hydriding rate and its mechanical properties were better than Zircaloy-2. The in-pile corrosion rates of the $Zr-Nb_3-Sn_1$ alloy exposed to integrated neutron dose in the range of 10^{19} nvt are given. A semi-statistical method for determination of an optimized alloy composition satisfying pre-established specifications and its application to the definition of a specific Zr–Cr–Fe alloy is described. (auth)

18219 EFFECT OF VARIOUS ADDITIVES ON THE COMPATIBILITY OF ZIRCONIUM WITH LIQUID SODIUM. Champeix, L.; Graff, W.; Sannier, J. (CEN, Saclay, France). pp 63-75 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

The behavior of Zr–Cu alloys (containing 1 to 2.5% of Cu) was tested at temperatures between 650 and 800°C in the presence of static Na, in hermetically sealed capsules made of 18 Cr/10 Ni austenitic steel or Zircaloy. Under these conditions the resistance of these materials to corrosion was very good, similar to that of unalloyed Zr. The corrosion kinetics of these same Zr–Cu alloys, and of the alloys Zr–1.5% Al, and Zr–1.5% Al–1.5% Mo–1.5% Sn, were determined at 550 and 700°C in flowing Na, for periods reaching 2,000 hr. If the Na is purified by the hot trap method corrosion remains very slight, at least up to 550°C. The weight increases observed are 10 to 30 times lower than those formed with a simple cold trap Na purification. In this latter case constant kinetics were established after about 500 hr, and the weight increases that remains less than 0.2 mg/cm²/1,000 hr at 550°C, and 2 mg/cm²/1,000 hr at 700°C; no case of breakway was found. However, the addition of Al to Zr seemed to give some protection at 700°C. (auth)

18220 TRANSMISSION ELECTRON MICROSCOPY OF ZIRCONIUM AND ZIRCALOY-2 CORROSION FILMS FORMED IN AIR AND WATER. Douglass, D.-L. (General Electric Co., Pleasanton, Calif.); Van Landuyt, J. pp 155-72 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre

d'Etudes Nucleaires de Saclay, 1966 and Paris, Presse Universitaires de France, 1966.

Transmission electron microscopy of corrosion-oxidation films formed on both Van Arkel Zr and Zircaloy-2 in air from 250 to 450°C and in water from 225 to 325°C showed that gross differences existed in the film morphology depending on the environment and surface preparation. Annealed Zr oxidized in air formed monoclinic zirconia films, which replicated the metal grain structure but which also contained fine-grain regions, pseudo-amorphous areas, pustules, and preferentially oxidized grain boundaries. Etched Zr, oxidized under the same conditions, formed uniform films having only one heterogeneity, preferentially oxidized twins. (auth)

18221 OXIDATION OF ORIENTED THIN FILMS OF ZIRCONIUM. EPITAXIAL RELATION OXIDE-METAL. Denoux, M.; Trillat, J.-J. (CNRS, Bellevue, France). pp 173-80 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Oxidation of epitaxially oriented thin films of Zr under partial pressure of air, led to the formation of monoclinic ZrO_2 by cubic and quadratic transitory phases. The study of epitaxial relations between metal and the three structural modifications of oxide led to a scheme of these transformations by a preferential diffusion process. These results are compared with those from bulk-Zr platelets, which are oxidized in such conditions that, at the metal-oxide interface, the transitory phases mentioned above, are developed. (auth)

18222 GERMINATION AND GROWTH PHENOMENA DURING THE SURFACE OXIDATION OF ZIRCONIUM. Beranger, G.; Lacombe, P. (Ecole des Mines, Paris). pp 181-91 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Development of the oxide layer formed on Zr in controlled oxidation under low-oxygen pressure at high temperature was studied; the formation of preferential oxide growths was observed at the bottom of the grain boundaries, afterwards at the center of the grain in the form of needles. It was possible to connect the aspect of the growth with the texture of the metal. The morphological appearance of the oxide during oxidation, either by direct observation or by examination after detachment of the oxide. At different stages of its formation the structure of the oxide was examined by x-ray diffraction and by reflection and transmission electron diffraction. A relation was established between the changes observed in zirconia during electron-migration experiments and during the oxidation of zirconium. From this an interpretation of the change in color of the oxide connected with the phenomenon of break-away was derived. (auth)

18223 ZIRCONIUM ALLOYS. Raine, Thomas; Robinson, James Alan (to Associated Electrical Industries, Ltd.). British Patent 1,057,369. Feb. 1, 1967. Filed Dec. 19, 1962.

A Zr alloy containing 0.5 to 1.5 wt % Cu, 0.25 to 1.5 wt % W, and 0.2 to 3.0 wt % Nb exhibits considerable resistance to corrosion by steam, CO_2, air, or CO_2–air mixtures at 280 to 500°C. (B.L.M.)

Preparation and Fabrication

Refer also to abstracts 18292 and 18311.

18224 (BM-RI-6915) RHENIUM AND RHENIUM-TUNGSTEN DEPOSITION BY THERMOCHEMICAL REDUCTION OF THE HEXAFLUORIDES. A Preliminary Study. Hoertel, F. W.; Donaldson, J. G. (Bureau of Mines, Washington, D. C.). Aug. 1966. 14p. Bureau of Mines Free.

Near-optimum parameters were determined for vapor deposition of Re on heated Cu substrates by H_2 reduction of ReF_6. High-purity deposits of nearly 90% theoretical density were obtained with the reaction chamber at 250°C, with an H_2 to ReF_6 volume ratio of 25 to 1, and with an ReF_6 flow rate of 5 grams per hour. Some Re was deposited as a loose, black powder. When the established near-optimum parameters were carefully followed, this could be minimized but never completely avoided. Varying the reaction chamber pressure, both above and below atmospheric, yielded excessive quantities of Re powder. Deposition efficiencies, based on only the coherent metal, ranged between 70 and 75 percent. Massive deposits contained only spectrographic traces of impurities. The average microhardness (Knoop, 100-gram load) of vapor-deposited rhenium was 907. Limited research on the deposition of Re–W alloys by reduction of the mixed hexafluorides produced deposits in which linear composition gradients were pronounced; this nonhomogeneity was attributed to the wide variation in optimum H_2-reduction temperatures of the two hexafluorides (250°C for ReF_6 and 550°C for WF_6). Using deposition temperatures between 250 and 550°C did not eliminate the composition variations. (auth)

18225 (BNWL-379) EVALUATION OF SOLID STATE PURIFICATION OF MOLYBDENUM. Bennett, W. S.; Smidt, F. A. Jr. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Several types of Mo were processed in a system employing a recirculating, gettered H_2 atmosphere for C removal. At temperatures up to 1400°C, no removal of C was detected. It was concluded that solid state purification of Mo is not possible by the ZrH_2 method. The most likely possibilities for this failure are discussed. (P.C.H.)

18226 (GA-7127) PRINCIPLES OF PLUTONIUM METALLOGRAPHY. Cochran, F. L. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 2, 1966. Contract AT(04-3)-167. 40p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review is presented on the optical metallography of Pu and some of its alloys. Topics discussed include: glove-box design philosophy; physical properties; preparation; mechanical grinding and polishing; electrolytic polishing; etching; autoradiography; high-temperature examination; quantitative examination; quantitative point count; replication; and remote systems. (64 references). (P.C.H.)

18227 (HW-30040) PLUTONIUM TRIFLUORIDE; PREPARATION BY REACTION WITH FREON-12, AND BOMB REDUCTION TO METAL. Smith, R. C.; Roake, W. E. (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Sept. 15, 1953. Contract W-31-109-eng-52. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Freon-12 (CF_2Cl_2) was found to be an excellent gaseous reactant for converting $Pu(C_2O_4)_2$ and the "low temperature" form of PuO_2 to PuF_3 by reaction at 400°C. PuF_3 produced in this manner is easily reduced with good yield to a well-formed metal button by the stationary bomb technique using Ca as a reductant. The optimum conditions for reduction on a twenty-gram scale are a 30 percent excess Ca, between 0.6 and 1.0 mole each of Ca and I_2 per mole of Pu (as a thermal booster), and post firing heating for at least one minute after the reaction has taken place. Yields of 95 to 97 percent are obtained. The chemical inertness of Freon-12 at ordinary temperatures is well known. Preliminary corrosion studies indicate the corrosion of Inconel, Haynes 25, and Hastelloys A, B, and C by Freon-12 and the products of the reaction, which produces PuF_3, to proceed at rates less than 10^{-3} inches per month at the temperature required for the reaction. (auth)

18228 (IITRI-578P29-8) RESEARCH ON ZIRCALOY BRAZE ALLOY DEVELOPMENT. Quarterly Report, October 1–December 31, 1966. Kizer, Deral E.; Saperstein, Z. P. (IIT Research Inst., Chicago, Ill.). Jan. 17, 1967. Contract AT(11-1)-578. 12p. (IITRI-B6064-8; EURAEC-1810). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments in the production of a braze alloy suitable for joining Zircaloy-clad fuel elements for use in a pressurized water reactor are reported. Most of the zirconium-base binary alloys have been brazed and are being tested in autoclaves. A second series of braze alloy candidates are being prepared for similar evaluation. (auth)

18229 (NASA-SP-5064) NASA CONTRIBUTIONS TO METALS JOINING. Reichenecker, W. J.; Heuschkel, J. (Westinghouse Electric Corp., Pittsburgh, Pa.). 1967. 143p. GPO $0.60.

A review is presented on metals joining procedures relating to NASA-sponsored projects and programs. The procedures include nonwelding and welding processes and plasma spray bonding. Methods for light metals, refractory metals, and V are also discussed along with dissimilar metals joining and sealing, electronic component interconnections, and fracture testing. Data on nominal composition of Al alloys are appended. (52 references). (P.C.H.)

18230 (NLCO-916) CONSUMABLE-ELECTRODE ARC MELTING OF URANIUM. Schardt, R. L. (National Lead Co. of Ohio, Cincinnati). Mar. 1967. Contract AT(30-1)-1156. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Electrodes for arc-melting were produced by vacuum-induction-melting U feedstock and casting it into $5\frac{1}{2}$-; 8-; and 9-inch-diameter molds. These electrodes were arc-melted in a vacuum into 7-, $7\frac{3}{8}$-, 10-, and 11-inch-diameter (production-size) ingots. Procedures for the arc-melting of U were established and the effects of the process on the residual impurity levels in the U

ingots were determined. Metallographic studies showed that the inclusions were finely divided and evenly distributed. Chemical analyses indicated that no chemical refinement, except for a small reduction in hydrogen content, could be attributed to the arc-melting process. Limited cladding and reactor tests indicated that fuel cores fabricated from arc-melted U performed as well as cores from regular induction-melted stock. (auth)

18231 (NMI-2200,11) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. DEVELOPMENT OF A FABRICATION PROCESS FOR ZIRCALOY-ALUMINUM COMPOSITE PRESSURE TUBING. Final Report, July 15, 1965-July 15, 1966. White, A. M. (Nuclear Metals, Inc., West Concord, Mass.). July 15, 1966. Contract AT(30-1)-2784. 60p. Dep. mn, CFSTI $3.00 cy, $0.65 mn.

Fabrication methods were investigated for Zircaloy-4 pressure tubes lined on the inside with Al. Since bonding was required to withstand thermal cycling, the bond was determined primarily by ultrasonic testing before and after various thermal treatments. Methods involving low deformation showed little promise of success and, therefore, were not investigated extensively. Ball-sizing, i.e., extrusion of an Al sleeve by pulling an over-size plug through it so that it elongated and came in contact with the Zircaloy surrounding it, gave results which were usually good at 950°F but the quality decreased as the processing temperature was lowered. Lubrication was not satisfactory at the higher temperature but better inside surfaces were obtained as the processing temperature was decreased. Further evaluation is required, but it appeared that a zinc electroplate on the mating surface of the Al permitted bonding to occur by ball-sizing at about 650°F. Lubrication is facilitated at this temperature. There was evidence that zinc on the inner surface facilitated lubrication at 650°F. Coextrusion was investigated in a small auxiliary effort. The two metals could be coextruded but wavy surfaces were obtained. When SAP was substituted for 2S Al, good surfaces resulted. The coextruded samples were used in diffusion experiments which showed that interdiffusion between Al and Zircaloy was greater than between SAP and Al. (auth)

18232 (NP-16626) BI-MONTHLY PROGRESS REPORT [ON DEVELOPMENT OF HIGH PURITY Be ALLOY SHEET], DECEMBER 1966-JANUARY 1967. Denny, John P. (Beryllium Corp., Reading, Pa.). Feb. 20, 1967. Contract NOw-66-0563-c. 11p.

Rolling procedures were used for 1000°F conversion of Be-Cu alloy ingot slabs into sheet followed by annealing and metallographic characterization. Additional tensile data were obtained on alloy slab extrusions, and initial bend testing work was performed. Nickel cladding was procured for future 800°F rolling experiments. (P.C.H.)

18233 (ORO-2581-1) TOPOLOGICAL STUDY OF THE SINTERING PROCESS. Annual Progress Report, February 1967. (Florida Univ., Gainesville. Engineering and Industrial Experiment Station). Contract AT(40-1)-2581. 102p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Studies were made on the evolution of structure during sintering, the rate at which the structure evolves, and the relations that operate in the interplay between structure and kinetics. The application of the techniques of quantitative metallography to the study of sintering systems provided fairly detailed, reliable, and significant information about the variation of several geometric parameters as sintering proceeds. The average velocity of pore-solid interface was introduced as a new function to monitor sintering rate. (P.C.H.)

18234 (WAPD-TM-620) SIZING OF ZIRCALOY STRUCTURALS. Suidan, J. H.; Krahn, R. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Feb. 1967. Contract AT(11-1)-Gen-14. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Experiments in sizing large tubular Zircaloy structurals for nuclear core application by thermal, explosive, and cold hydraulic sizing techniques reveal that thermal sizing is the most suitable process of the three in achieving the required tight diametral and boundary surface tolerances. With cylindrical tubes up to 11½ inches in diameter by 103 inches long and wall thicknesses of 0.062 inch, tolerances which can be met consistently around any desired nominal diameter are ±0.020 and plus 0.025 inch for the diametral tolerance and boundary diameter, respectively. As a result of strain-rate sensitivity of Zircaloy and limitations placed on the amount of elongation permitted which precluded removal of ovality, experiments in explosive sizing were discontinued. Cold hydraulic sizing experiments were discontinued because of the dimensional instability of the sized component under subsequent thermal cycling. (auth)

18235 ACTIVATED SINTERING OF TUNGSTEN WITH SMALL ADDITIONS OF NICKEL. Panichkina, V. V. (Inst. of Problems in Materials Management, Academy of Sciences, Ukrainian SSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 1-5(Feb. 1967). (In Russian).

During sintering of W with 0.5% Ni, shrinkage of the samples was observed at 1100°C. The method of Ni introduction did not affect the sintering. In the process of sintering a solid solution, W-Ni, appeared instead of Ni particles. The formation of the second phase was confirmed by analysis on an electronic probe. (auth)

18236 PRODUCTION AND CHARACTERISTICS OF SEMI-FINISHED BERYLLIUM PRODUCTS. Logerot, J. M. Ann. Mines, 966-76(Oct.-Nov. 1966). (In French).

Difficulties in fabrication of Be are discussed from the viewpoint of heat treatment, purity, brittleness, grain structure, and orientation. Procedures for reducing these difficulties and for more objective physical testing methods are proposed. (P.G.C.)

18237 SEMI-INDUSTRIAL PREPARATION OF HIGH-PURITY NIOBIUM AND ITS ANALYTICAL CONTROL. Joly, F.; Saint-Cricq, J. Ann. Mines, 827-41(Oct.-Nov. 1966). (In French).

A process is described for pilot-plant production of 50-lb lots of 99.98% Nb. Procedures for chemical and metallurgical purification and improvement of analytical methods are discussed. Distillation of $NbCl_5$ was selected for chemical purification, which provided efficient removal of Ta, W, and Mo. $NbCl_5$ was hydrolyzed to Nb_2O_5 and the latter reduced by carbon under vacuum to metallic Nb. Purification of the metal by C, N, H, and O removal was achieved by repeated electron-beam melting which eliminated also Fe, Si, Ti, Ni, and other elements more volatile than Nb. Data are given on the extent of purification at the different steps of processing. Finally the Nb ingots were fabricated into sheets. Problems of contamination in the rolling and annealing steps are discussed. Analytical studies were directed towards refinement of existing methods, and evaluation of new methods for trace analysis of Nb, to achieve sufficient sensitivity and precision in the range of 1 to 10 ppM. A brief account is given of the various techniques involved, especially for the interstitial elements O, C, N, and H, with emphasis on physical methods such as neutron activation and internal friction. (BBB)

18238 HEAT-RESISTANT GALVANIC ELECTROPLATING OF MOLYBDENUM AND TUNGSTEN. Kvokova, I. M.; Lainer, V. I. pp 100-7 of Zharostoikie Pokrytiya. Borisenko, A. I. (ed.). Leningrad and Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

A double-layer nickel-chromium plating on molybdenum and tungsten prevented the gaseous high-temperature corrosion of these high-melting metals. A two-layer plating of about 180μ nickel prevented molybdenum oxidation at 900°C for 300 hr. In order to prevent Mo diffusion into Ni a thin barrier of silver or gold (20 to 40μ) was applied on Cr with a reduced chromium-nickel plating to 30 and 60μ thickness, respectively. (R.V.J.)

18239 WELDING MOLYBDENUM AND TUNGSTEN BY TIN BASE SOLDER. Nikiforova, Z. V.; Nesterov, B. M.; Sharov, O. A. Svarochn. Proizv., No. 3, 19-22(Mar. 1967). (In Russian).

A welding method for molybdenum and tungsten with preliminary treatment of the surface with metal oxides that do not react with the material is described. Welding of a freshly reduced surface coated with finely dispersed oxides of the same metals and further reduced in hydrogen media at certain temperature showed good results with tin-, silver-, or copper-base solder. (R.V.J.)

18240 EFFECT OF TITANIUM, ZIRCONIUM, AND HAFNIUM ON THE PROPERTIES OF ALLOYS OF MOLYBDENUM WITH CARBON. Morgunova, N. N. Metalloved. Term. Obrabotka Metal., No. 12, 40-4 and insert facing page 32(Dec. 1966). (In Russian).

The recrystallization temperature and rupture strength of vacuum arc-melted molybdenum-base alloys with 0.25 or 0.5 at. % C, Ti, Zr, or Hf were investigated. Rough-machined alloy ingots, 70 mm in diameter, after heating in an argon atmosphere at 1700°C for 3 hr, were forged first into 40-mm square bars and then at 1400 to 1200°C into rods 16 mm in diameter. The recrystallization temperature of the alloys was determined by measuring the HRC microhardness of the alloys vacuum annealed at 900 to 1200°C for 1 hr. The 100-hr rupture strength was measured in vacuum at 1400°C on alloys vacuum annealed at 2000°C for 3 hr. It was found that increasing the carbon content from 0.25 to 0.5 at. % did not raise the recrystallization temperature of molybdenum (1000°C) or rupture strength. But in molybdenum alloyed with 0.25 at. % C, an 0.25 at. % addition of Zr, Hf, or Ti increased the temperature of the beginning of alloy recrystallization from 1000 to 1400, 1300, and 1100°C, respectively, and the rupture strength from 2.8 to 9.0, 3.5, 2.9 kg/mm². The corresponding figures for molybdenum alloyed with 0.5 at. % C and 0.5 at. % Zr, Hf, or Ti were 1600, 1800,

and 1300°C, respectively; the respective increase in the rupture strength was from 2.0 to 10, 9.5, and 5.0 kg/mm². These figures show that when carbon is present in molybdenum, titanium is the least effective alloying element for increasing the temperature of the beginning of recrystallization or the heat resistance of molybdenum-base alloys. Zirconium is the most effective addition in alloying with up to 0.25 at. %, and hafnium in alloying with up to 0.5 at. % carbon. (auth)

18241 MICROSTRUCTURE AND MECHANICAL PROPERTIES OF EXTRUDED TsM2A MOLYBDENUM ALLOY. Manegin, Yu. V. Metalloved. Term. Obrabotka Metal., No. 12, 44-8 and insert facing page 33(Dec. 1966). (In Russian).

TsM2A molybdenum alloy ingots (0.07 to 0.3% titanium, 0.07 to 0.15 % Zr, impurities not exceeding: 0.003% oxygen, 0.005% nitrogen, 0.001% hydrogen, and 0.004% carbon) 78 mm in diameter were extruded at 1000 to 1600°C into bars 20 to 45 mm in diameter, i.e., with respective reductions of 94 to 68%. The grain size of the as-cast alloy was 2 mm and up. In the extruded alloy, the grains became oriented in the direction of deformation and were elongated, with a fibrous structure. Extrusion at 1000 to 1150°C with a reduction of 68% did not eliminate the cast structure. Only extrusion at 1300 to 1600°C with a reduction of 75% eliminated the cast structure completely and reduced the grain size to 0.05 to 0.15 mm. In alloy extruded at 1600°C, a recrystallization was observed. At a reduction of 81%, recrystallization extended throughout the cross section of extruded bars. Extrusion increased the strength of alloy by 50 to 100%, compared with the as-cast condition. With increasing extrusion temperature, the strength decreased. Alloy extruded at 1150 to 1300°C, at a high tensile strength (100 kg/mm²) had a relatively high ductility (elongation 15%). (ATD)

18242 STRUCTURE AND PROPERTIES OF NIOBIUM–TANTALUM ALLOYS CONTAINING TUNGSTEN AND MOLYBDENUM. Vasil'eva, E. V.; Prokoshkin, D. A.; Belova, L. M. Metalloved. Term. Obrabotka Metal., No. 12, 21-4 and inserts facing pages 48-9(Dec. 1966). (In Russian).

The effect of tantalum (0.5, 1, 5, 10, or 15%), molybdenum, and tungsten (5% of each) on the microstructure and room and high-temperature hardness of niobium-base alloys was investigated. The alloys were melted in a nonconsumable (tungsten) electrode, vacuum-arc furnace in an argon atmosphere. Alloy ingots were annealed at 1700°C for 50 hr. It was found that the microstructure of cast Nb–Ta alloy had the typical structure of a single-phase solid solution. With increasing tantalum content, the substructure became more distinct. As-cast Nb + 5% Ta + 5% Mo and Nb + 10% Ta + 5% Mo alloys also had a single-phase structure with elongated grains and traces of dendritic segregation. A noticeable segregation of impurities was observed in Nb + 5% Ta + 5% W and Nb + 10% Ta + 5% W alloys. The respective hardness at 20 and 1000°C of Nb + 10% Ta alloy was 180 and 105 HV. Additional alloying with 5% molybdenum or 5% tungsten increased the hardness to 198 and 127 HV or to 192 and 120 HV, compared with 150 and 90 HV for unalloyed niobium. The creep rate (calculated from the results of hot hardness tests) of alloys containing molybdenum and tantalum was the lowest and that of alloys containing tantalum and tungsten the highest. (ATD)

18243 EFFECT OF COLD PLASTIC DEFORMATION AND ANNEALING OF THE MECHANICAL PROPERTIES OF NIOBIUM SHEETS. Zhorova, L. P.; Zakharova, G. V. Metalloved. Term. Obrabotka Metal., No. 12, 28-31(Dec. 1966). (In Russian).

The effect of cold rolling, direction of rolling, and annealing on the mechanical properties of niobium at room and high temperature was investigated. Niobium ingots, 75 mm in dia and 150-mm high, melted in a vacuum arc furnace and homogenized at 1800°C in an argon atmosphere for 10 hr, were extruded at 1500°C into sheet bars 35 to 40 mm thick, which, after reheating to 1500°C, were rolled to a thickness of 12 to 15 mm, conditioned by machining, vacuum annealed, and rolled into sheet 1-mm thick at about 150°C. Sheet specimens (50 × 10 × 1 mm) were then cold rolled with 50, 70, 80, 90, or 99% reduction without process annealing. It was found that cold rolling with a reduction of more than 70% significantly strengthened niobium. Specimens rolled with 90% reduction and tested at 20, 700, 1100, 1300, or 1500°C had a tensile strength of 71 to 77.2, 52.6 to 53.2, 22 to 24, 9, 9.7, and 7.5 to 8.3 kg/mm², respectively, compared with 50 to 51, 40 to 42, 19.5 to 20.5, 10.1, and 7.5 to 8.9 kg/mm² for specimens annealed at 1300°C for 1 hr. Cold rolling produced a considerable anisotropy of strength and ductility, which, however, was completely eliminated by annealing at 1300°C for 1 hr. Annealing at 1500 to 1800°C increased the grain size from 0.06 to 0.9 mm. (ATD)

18244 STRUCTURE AND MECHANICAL PROPERTIES OF THE ALLOYS OF THE Nb–V–Ti SYSTEM. Lazarev, E. M.; Vasil'eva, E. V. Metalloved. Term. Obrabotka Metal., No. 12, 31-3 and insert facing page 48(Dec. 1966). (In Russian).

Niobium-base alloys containing 1 to 15% vanadium and 1 to 10% titanium were melted from 99.78%-pure niobium, iodide vanadium, and iodide titanium. The as-cast alloys had a dendritic microstructure which became more pronounced with increasing vanadium content. Alloys annealed in vacuum at 1400°C for 25 hr had equiaxial grains. Increased titanium and vanadium content increased the hardness. The effect of vanadium is more pronounced. An increase in vanadium content from 0 to 15% increased the tensile strength from 47.5 to 107.5 kg/mm² in alloys containing 10% titanium and from 34.3 to 83.6 kg/mm² in alloys containing 1% titanium. The yield strength also increased with increased vanadium and titanium content. The ductility generally dropped with increasing titanium or vanadium content, titanium being more effective than vanadium. (ATD)

18245 MECHANICAL PROPERTIES OF NIOBIUM AND ITS ALLOYS AT LOW TEMPERATURES. Zakharova, G. V.; Ermakova, E. M.; Belyaev, S. E. Metalloved. Term. Obrabotka Metal., No. 12, 34-6(Dec. 1966). (In Russian).

Specimens of VN1 niobium and VN2 and VN2A niobium alloy, as-deformed, stress-relieved at 1100°C, or recrystallization annealed at 1200°C, were subjected to tensile and impact tests at –253 to 20°C. It was found that stress relieving had little or no effect on the mechanical properties of VN1 niobium. Recrystallization annealing lowered the tensile strength from 98 to 89 kg/mm², the yield strength from 95 to 88 kg/mm², and increased the elongation from 15 to 21% and the notch toughness from 19 to 25 kgm/cm² (tested at –196°C), compared with as-deformed alloy. The microstructure of recrystallized VN1 niobium was uniform and fine-grained. Alloying with molybdenum was found to raise the nil ductility transition temperature. Consequently, the molybdenum content in niobium alloys should not exceed 4%. Additional alloying of niobium-molybdenum alloys with zirconium significantly increased their ductility and notch toughness at –196°C. Lowering the test temperature to –253°C resulted in increased tensile and yield strength and decreased elongation and notch toughness in NV2A niobium alloy. The sharp change in mechanical properties at –196 to –253°C indicates that the alloy has a tendency to embrittlement. Fracture of VN2 alloy specimens was ductile at 20 and –196, and brittle at –253°C. The results of tests showed that VN2A niobium alloy can be used in structures operating under multiaxial stresses at high and low temperatures. (ATD)

18246 STRUCTURAL CHANGES DURING ANNEALING OF DEFORMED NIOBIUM AND ITS ALLOYS. Gorelik, S. S.; Spektor, E. N.; Burdasova, T. A. Metalloved. Term. Obrabotka Metal., No. 12, 24-8(Dec. 1966). (In Russian).

The recrystallization behavior of commercial-grade niobium, niobium alloy with 4% molybdenum, and molybdenum alloy with 0.15% zirconium was investigated. Extruded, rolled, and annealed alloy sheets were cold rolled with 80 to 90% reduction and vacuum annealed at 500 to 1500°C for 2 hr. It was found that the temperature of the beginning of recrystallization for niobium was 1050°C, whereas that of the other alloys was 1150°C. It is noted that in alloys deformed by stretching, the temperature of the beginning of recrystallization was 100 to 200°C higher than that in rolled alloys due to a more uniform deformation in stretching. The entire recrystallization range for niobium alloy was found to be 100 to 150°C, and that for molybdenum alloy, 200 to 250°C. Annealing of deformed niobium alloys in vacuum of 1×10^{-4} mm Hg brings about a significant absorption of oxygen, which increases with increased temperature; at 1400°C the amount of absorbed oxygen reaches 0.1%. Annealing of molybdenum alloys under the same conditions does not cause a similar effect, apparently due to a different type of oxidation. Stresses of the first order, with a magnitude of up to 10 to 15 kg/mm², nonuniformly distributed along the length of specimens, developed in niobium–molybdenum alloy under the effect of stretching. No such phenomena were observed in molybdenum–zirconium alloy. (ATD)

18247 EFFECT OF THE ANNEALING TEMPERATURE ON THE STRUCTURE AND PROPERTIES OF CAST MOLYBDENUM. Malevskii, Yu. B.; Novikova, D. B. Metalloved. Term. Obrabotka Metal., No. 12, 50-3(Dec. 1966). (In Russian).

Specimens (2 × 2 × 45 mm) of 99.97%-pure electron-beam melted molybdenum, as-cast or vacuum annealed at 700 to 1500°C for 45 min, were subjected to bend tests to determine the effect of the annealing temperature on the metal structure and ductility. The as-cast specimens failed in a brittle manner at a bend angle of 30 deg, but specimens annealed at 900 and 1200°C sustained a bend angle of 180° without failure. Specimens annealed at 1400 and 1500°C first cracked at a bend angle of 150 and 60° and failed along the grain boundary at a bend angle of 175 and 60°, respectively. Electron microscope examination revealed the presence of molybdenum oxides and carbides at the grain boundaries in the as-cast specimens, and within the grains at a distance of 1 to 2 mm from the grain boundaries in the specimens annealed at 1300 to 1400°C.

Thus, high ductility in molybdenum annealed at 900 to 1200°C was brought about by eliminating impurities from the polygonal grain boundaries. Lower ductility in molybdenum annealed at 1500°C is believed to be caused by microporosity, which was observed in the specimens and probably resulted from coagulation of vacancies, or from vaporization of molybdenum trioxide from the grain boundaries. (ATD)

18248 THE ELECTRON-BEAM MELTING OF REFRACTORY METALS. VI. THE FLOATING-ZONE MELTING OF REFRACTORY METALS BY ELECTRON-BEAM BOMBARDMENT. Takaai, Tetsuya (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 30: 1017-21(1966). (In Japanese).

An electron-beam floating-zone melting apparatus was assembled consisting of a vacuum system, power supply, anode supports, and traversing cathode. The acceleration voltage of maximum 10 kV was supplied to the specimen (anode), while the W-filament (cathode) was nearly earth potential. Electron-beam concentrators made of tantalum disks were effective for obtaining higher temperatures in specimen rods. For example, the use of a single concentrator or paired concentrators resulted in a rise of the specimen temperature about 250 to 450°C higher than with no concentrators. The substantial heat-quantities required for actual zone-melting experiments agreed well with literature values. In the zone-melting process of titanium and zirconium, the vacuum in the melting chamber and the firing wattage given to the W-filament showed unique changes. (auth)

18249 THE ELECTRON-BEAM MELTING OF REFRACTORY METALS. VII. SOME PROPERTIES OF FLOATING-ZONE MELTED MOLYBDENUM, TUNGSTEN, AND TANTALUM. Takaai, Tetsuya (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 30: 1022-6(1966). (In Japanese).

The refining effects of floating-zone melting on molybdenum, tungsten, and tantalum were investigated from their mechanical properties and chemical analysis. Floating-zone melted tungsten and molybdenum rods showed excellent bent ductility at room temperature. By the floating-zone melting method, tungsten and molybdenum grew to single crystals rather easily, and their crystal orientations were almost near the (111) direction. By tensile tests, zone-melted molybdenum and tantalum rods showed fractures of the chisel-type break pattern, and no yielding was observed. Compression-strain-hardening exponents of the floating-zone melted molybdenum and tungsten rods were smaller than those of the starting materials, but in the case of the tantalum rod, the strain-hardening exponent of the zone-melted part was somewhat larger than that of the starting rod. The resistance ratio of the zone-melted molybdenum rod was 2.8×10^{-4} against 4.0×10^{-2} in the starting rod and 3.2×10^{-2} in the recrystallization zone. (auth)

18250 QUANTITATIVE ANALYSIS OF TEXTURES DEVELOPED IN A HOT-EXTRUDED ZIRCONIUM PLATE. Couterne, J.-C. (CEN, Saclay, France); Cizeron, G.; Lacombe, P. pp 135-54 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

The Schulz method was used to study the textures produced in Zr by hot-extrusion of a cylindrical rod at 730°C to form a plate of rectangular cross-section. These textures were determined either parallel to the plane of the plate or parallel to that of the edges (this plane is at right angle to the first and also parallel to the direction of extrusion). Results show that especially near the edges of the plate, some components of the textures observed in the two series of recordings are the same texture seen from two different angles. In addition it is shown that Zr shaped in this way shows two main types of texture: either from cold-work, or from recrystallization following it. (P.C.S.)

18251 THE ELECTRON-BEAM MELTING OF REFRACTORY METALS. VIII. THE ELECTRON-BEAM MELTING OF TUNGSTEN. Takaai, Tetsuya (Hitachi Ltd., Tokyo). Nippon Kinzoku Gakkaishi, 30: 1027-31(1966). (In Japanese).

Electron-beam melting of tungsten was studied by spectroscopic analysis, x-ray diffraction of columnar crystal grains, and considerations of recrystallization behaviors. The evaporation-rate of tungsten during the electron-beam melting was about 10 to 25% of the charged weight. The actual melting-operation temperature was estimated to be about 4100 to 4200°K from the measured evaporation rates. The electron-beam melted tungsten ingot consisted of well-collimated long columnar crystal grains. The crystal orientations of these columnar crystal grains were distributed near (011) - (223) zone of the stereographic triangle. The orientation relation between the upper and lower columnar grains in the electron-beam melted tungsten ingot reveals that the growth of the upper columnar crystal grains takes place almost epitaxially along the crystal orientation of the lower columnar crystal grains. From the changes in elongation and ultimate tensile strength due to annealing, the recrystallization temperature of the electron-beam melted tungsten was measured to be 900 to 1000°C, in a way consistent with the sintered tungsten. However, there was a marked difference in the recrystallized microstructure between the electron-beam melted and the sintered tungsten. (auth)

Properties Evaluations

Refer also to abstracts 17564, 18232, 18321, 18333, and 18358.

18252 (AD-637748) FIELD ION MICROSCOPY AND A STUDY OF THE TUNGSTEN-CARBON ALLOY SYSTEM. French, R. D.; Richman, M. M. (Brown Univ., Providence, R. I. Div. of Engineering). Aug. 1966. Contract SD-86. 71p. (E-33). CFSTI $3.00 cy, $0.65 mn.

Thesis.

The field ion microscope (FIM) has the highest resolution yet attainable; its magnification power being of the order of 1,000,000 X. A review of technique and theory shows that the microscope has a built-in capability of searching a specimen along a third dimension by removal of surface atom layers. Using the FIM to study the W–C system, this technique of evaporation allows one to investigate the distribution of C about slip bands and the distortion of the W host lattice due to the presence of the C interstitial. A model is presented for determining C content in carburized specimens. The presence of carbides is discussed along with the effect of the interstitial atom on the W surface layer. Suggestions for improvement and extended work are presented. (auth)

18253 (AGN–8214) EVALUATION STUDY OF HASTELLOY X AS A NUCLEAR CLADDING. Quarterly Progress Report, October 1–December 31, 1966. (Aerojet-General Corp., San Ramon, Calif. Nuclear Products and Services Group). Feb. 1967. Contract AT(04-3)-368. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The mechanical properties and oxidation of Hastelloy X were evaluated for use as nuclear cladding material. The oxidation penetration data for low and commercial tubing exposed at temperatures between 1300 and 1800°F were analyzed to determine the time and temperature dependence of this reaction. The results indicated that the limiting oxygen transport mechanism changes from diffusion through the oxide film to diffusion through the metal matrix at temperatures low in this range. Regression analyses of the penetration data were performed to determine activation energies for the oxidation reaction. Room temperature tensile testing of specimens exposed up to 7500 hr at 1900 and 2000°F was completed. All samples tested reached a ductility maximum after 100 hr exposure, followed (in samples from two heats) by a sharp decrease in ductility after 1000 hr. Tensile creep curves were typified by initially increasing creep rates that reach a maximum depending upon applied stress. Bending creep curves followed a more classical form, having a short primary creep stage followed by an extended secondary stage. (P.C.H.)

18254 (EUR–3267.e) THE THERMAL RELEASE OF KRYPTON FROM THIN LAYERS OF UO_2. Gautsch, O.; Mustacchi, C.; Schuerenkaemper, A.; Wahl, H. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Nov. 21, 1966. 22p. Dep. mn.

The release of Kr from thin UO_2 layers was investigated. One type of experiment consisted of annealing sintered UO_2 pellets previously bombarded with Kr ions of a few keV. In a second type of experiment layers of recondensed UO_2, containing between 0.04 and 0.1 Kr atoms per atom of U, were annealed. (auth)

18255 (EURAEC–1595) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 12. Siegfried, W.; Zimering, S. (Battelle Memorial Inst., Geneva (Switzerland)). Mar. 1966. Contracts 100-62-12 RDS; 057-64-7 TEES (RD). 13p. (EUR–2816). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Mathematical formulas were developed to improve temperature extrapolation of time-to-rupture tests of metals, both with neutron irradiation and without neutron irradiation. (P.G.C.)

18256 (EURAEC–1783) [MECHANICAL CHARACTERISTICS OF AUSTENITIC STEELS]. Quarterly Report No. 7, April–June 1966. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Departement des Recherches). Contract 033-64-9-TEEF(RD). 76p. (EUR–3325). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Creep characteristics of austenitic stainless steels at 600°C are reported as are results of stress corrosion tests on austenitic and austeno-ferritic stainless steel wires conducted in boiling $MgCl_2$ solutions at temperatures between 100 and 200°C. Techniques and equipment used to conduct the tests are described. (P.G.C.)

18257 (EURAEC–1788) STUDY OF THE BASE METAL INTENDED FOR RESEARCH ON THE BRITTLE FRACTURE OF LARGE WELDMENTS. Final Report No. 1. (Institut de Recherches de la Siderurgie, St. Germaine-en-Laye (France)). Dec. 1966. Contract 031-64-5-TEEF(RD). 62p. (EUR–3330). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The mechanical properties, including tensile strength and brittle fracture strength, structural transformations, and stress relief of Super-Elso steel (Ni–Cr–Mo steel) and AMMO steel (Mn–Mo–V steel) were investigated. Quenched and tempered Super-Elso steel (130 mm thick) had a fracture strength of about 80 kg/mm^2 and was chemically and structurally homogeneous throughout. Appreciable differences were found between the brittle fracture strength of the core and skin. Austenite transformation tests showed that the quenchability of this steel is high as regards stress relief. Normalized and tempered AMMO steel (200 mm thick) had good chemical homogeneity throughout; however, there was a 7 kg/cm^2 variation in the fracture load between the skin and the core. The transformation curves showed slight quenchability. (P.C.H.)

18258 (EURAEC–1797) ANNUAL REPORT [ON STUDIES OF STAINLESS STEELS], JULY 1, 1965–JUNE 30, 1966. Special Report No. 2. Chaudron, G. (Centre National de la Recherche Scientifique, Paris (France)). Contract 059-65-7-TEEF(RD). 10p. (EUR–3337). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Progress on investigations of the mechanical properties of high-purity stainless steels is reported. The effects of carbon concentration on the structure and mechanical properties were studied. Corrosion of stainless steels in superheated steam was also investigated along with stress corrosion phenomena. (M.C.G.)

18259 (EURAEC–1798) QUARTERLY REPORT NO. 2,32 [ON STUDIES OF STEELS], JULY 1–SEPTEMBER 30, 1966. (Chantiers de l'Atlantique Saint-Nazaire (France)). Contract 054-61-12-RDF. 3p. (EUR–3338). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Studies were made on the austenitization, expansion, and stress-relief properties of steel. Steels were superheated to 1250°C and re-austenitized at 900°C at varying rates of heating. It was found that for each steel there is a critical heating rate below which the austenitic superheating grain is hardly or not at all refined, which results in absence of regeneration after superheating. An increase in the content of alloying elements (Ni in particular) appeared to increase the critical rate. Transformation curves were determined for some of the steels studied. (P.C.H.)

18260 (EURAEC–1799) INVESTIGATION OF EMBRITTLEMENT OF REACTOR VESSEL STEELS THROUGH PLASTIC FATIGUE. Quarterly Report No. 10, April 1–June 30, 1966. (Centre National de Recherches Metallurgiques, Liege (Belgium)). Dec. 1966. Contract 005-63-12-TEEB. 22p. (EUR–3339). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Properties of plastic fatigue up to breaking point were measured in two steels (ZA and ZS) and static tensile properties after damage through plastic fatigue at 300°C were determined for steel ZA. The evolution of the bending moment as a function of plastic fatigue cycles with biaxial bending was studied on steel ZS. The plastic fatigue embrittlement at 300°C of a forged ZS steel was measured. Results of plastic fatigue embrittlement of the steels were analyzed from the point of view of the 30 ft lb (4.2 kg) criterion. (M.C.G.)

18261 (EURAEC–1800) QUARTERLY REPORT NO. 8 [ON STUDIES OF STEELS], JULY–SEPTEMBER 1966. (Compagnie des Ateliers et Forges de la Loire, Paris (France). Departement des Recherches). Contract 033-64-9-TEEF(RD). 77p. (EUR–3340). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments are reported for studies on: mechanical properties of steels without stress at different temperatures; structural evolution in austenitic and austeno-ferritic steels maintained for long periods at temperatures between 400 and 600°C; structural evolution of austeno-ferritic alloys, with and without silicon, at extended exposures between 300 and 600°C; structural evolution of austenitic steels after extended holding times at 500 and 600°C; stress corrosion tensile tests on wire in boiling solutions of Mg or NaCl; tests on 2 mm dia samples mounted on dynamometric rings; stress corrosion tests in vapor phase at 500°C; corrosion tests in water at 350°C and steam at 500°C. (P.C.H.)

18262 (HMI–B–49) UEBER DIE SPALTGASABGABE ZYLINDRISCHER UO_2-SINTERKOERPER (EDELGASE IN FESTKOERPERN 33). (Fission Gas Release of Cylindrical UO_2 Fuel Rods (Rare Gas in Solids 33)). Biersack, J. (Hahn-Meitner-Institut fuer Kernforschung, Berlin (West Germany)). Dec. 1966. 34p. (In German). Dep. mn.

The various processes of fission gas release are discussed. Fission gas diffusion (at 1000 to 1800°C) and gas release by moving bubbles (above 1800°C) are considered in detail. It was found that both cases can be treated quantitatively and that analytical expressions can be obtained for the fractional release. The calculations are performed for active as well as inactive fission gases, taking into account the radial temperature distribution within a long, cylindrical fuel element. The formulas are programmed for the use in digital computers. (auth)

18263 (NP–16617) EFFECT OF URANIUM ON THE TRANSVERSE DUCTILITY OF RESULPHURIZED CHROMIUM STAINLESS STEEL ROLLED PLATE. Crawford, W. M. (Department of Mines and Technical Surveys (Canada). Mines Branch). July 1966. 34p. (R–179). Dept. of Mines and Technical Surveys, Ottawa $0.75.

Tensile ductility in the transverse and longitudinal direction was investigated for AISI types 416 and 430F steels containing S at levels of 0.15% and 0.30% and corresponding uranium contents to give U:S ratios of approximately 0, 1, 4, and 7. The usual deleterious effect of S on ductility was demonstrated in the uranium-free steels and, in particular, the poor transverse ductility due to the presence of the sulfides as stringers was noted. Uranium was observed to have a pronounced effect on the morphology of the sulfides, suggesting a change in their chemical composition. At U:S ratios in the region of 4:1, globular sulfides replaced the stringers and the ratio of transverse/longitudinal ductility, as measured by per cent reduction of area, was of the order of unity. Also, in this condition, the 0.15%-S steels and the 0.30%-S steels showed similar ductilities. These beneficial effects were obtained for both grades of steel in the soft, annealed condition, and for Type 416 quenched and tempered to a higher strength. (auth)

18264 (NP–16649) VARIATION OF RESOLVED PROPORTIONAL LIMIT WITH MOSAIC ANGLE FROM 77°K TO 973°K IN ZONE REFINED TUNGSTEN. Simpson, Ronald Paul (Cornell Univ., Ithaca, N. Y.). Feb. 1967. Contract DA-31-124-ARO-D-228. 118p. Dep. mn.

W crystals were prepared and purified by electron beam zone refining. A range of mosaic block angles was obtained by controlling the temperature at the molten zone. The tensile axis of the single crystals was determined from Laue back reflection x-ray patterns, and tensile properties were then determined as a function of strain rate and temperature. The resolved proportional limit at constant strain rate of the W crystals varied over a mosaic block angle from 3 to an upper limit of 8 to 10. Both the resolved proportional limit and its range, as a function of mosaic angle, decreased with increasing temperature. Activation volumes were calculated, varying inversely with temperature for both mosaic limits. The range of resolved proportional limit with mosaic angle, at constant temperature and strain rate, is interpreted in terms of the variation of boundary energy with mosaic angle. The W crystals contained interstitial elements in excess of their solubility limit, even though their total interstitial content was below 100 ppM. The elements in solution have an increasing tendency to migrate to the mosaic boundaries with increasing temperature and mosaic angle, and consequently have an important effect on the resolved proportional limit. (auth)

18265 (NP–16657(Vol.2)) COLUMBIUM AND TANTALUM ALLOYS (TECHNICAL INFORMATION). VOLUME II. (Wah Chang Corp., Albany, Oreg.). Aug. 1966. 125p.

A compilation of technical data on the mechanical, chemical, and physical properties of several Nb and Ta alloys is presented. The alloys include WC-103, WC-129Y, WC-1 Zr, Cb-752, D-43, SCb-291, FS-85, Cb-132M, Ta-10 W, WC-111, WC-222, and TVC. (STAR)

18266 (ORNL–TM–1713) PREIRRADIATION EVALUATION OF THE PYROLYTIC-CARBON-COATED FUEL AND THE ASSEMBLY FOR THE ORR-A9-4 CAPSULE. Hewette II, D. M.; Coobs, J. H.; Beatty, R. L.; Kegley, T. M.; Leslie, B. C. (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results are presented for preirradiation evaluation of pyrolytic-carbon-coated UO_2 and UC_2 particles and preparation of the fuel assembly for the ORR-A9-4 capsule. In the metallographic evaluation of the fuel particles, it was discovered that the microstructure observed for a given type of coating was dependent on the polishing technique. (auth)

18267 (ORO-3396-2) DIFFUSION IN BINARY LIQUID METAL SYSTEMS. Progress Report, February 1, 1966–February 1, 1967. Canfield, Frank B. (Oklahoma Univ., Norman. School of Chemical Engineering and Materials Science). Contract AT(40-1)-3396. 99p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Mathematical relationships were developed for binary diffusion to show: Fick's second law should be applied only to systems which have constant partial molal volumes; the equivalence of the mutual diffusion coefficients in the center of moles and center of volume systems; and Darken's equations can be derived without the restriction of constant or equal partial molal volumes. It is shown that Fick's diffusion equation can be used to obtain binary diffusion coefficients from experimental data for either the volume or mole reference frame as long as the specific volume of the mixture follows a linear law over the concentration range employed. Mutual and self-diffusion coefficients were obtained for the liquid cadmium–lead system over the entire composition range at 623°K. The capillary reservoir technique was used employing ^{210}Pb and ^{115m}Cd as tracers. The self-diffusivities were found to be in agreement with data reported previously by others. Both isotopes were used to study the effects of overall concentration on the mutual diffusion coefficient. Several improvements in the capillary reservoir technique, which were necessary before mutual diffusivities could be obtained using this method, are described. (auth)

18268 (PB-173549) REPORT OF NRL PROGRESS. (Naval Research Lab., Washington, D. C.). Nov. 1966. 31p. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies on: use of thin-layer chromatography for identification of aircraft engine oil components; dry-film lubricants from MoS_2 bonded with microfibrous boehmite; organic adsorption at electrodes; perturbation times in alkali halide systems; engineering aspects of MB-5 aircraft fire-fighting and rescue vehicle; preparation of CrFe alloys proton damage to silicon solar cells; plane-strain fracture toughness of Al alloys; environmental fatigue; notch ductility behavior of A350-LF1 (Mod.) steel with multiple irradiation-annealing cycles; fractograph of Ti alloy; stress-corrosion-cracking characterization of high-strength Ti alloy weldments; a 5 kJ vacuum clamp switch for the Pharos 2-MJ capacitor bank; preparation of radiophotoluminescent ammonium sulfate complexes for fast neutron dosimetry; computer program for calculating components of the earth's magnetic field; and maximum utilization of FM subcarrier bandwidth. An article on thermal conductivity of high purity Re at 2 to 20°K is also included. (P.C.H.)

18269 WHERE SOVIET SUPERALLOYS STAND. Wagner, Herbert J.; Prock, Joseph Jr. (Battelle Memorial Inst., Columbus, Ohio). Metal Progr., 91: No. 3, 75-8(Mar. 1967).

United States and Soviet high-temperature alloys for use in rotating turbine blades, nozzle guide vanes, combustion cans, afterburner liners, and tailpipes are compared. Because of metal shortages, the Soviets use W in place of Mo, keep Al and Ti content below those of the U. S., use Co for only the most advanced alloys, and introduce V to increase hot-forgeability of wrought alloys. Both the West and the Soviet Union have developed precipitation hardenable Ni-base alloys for turbine blades and disks. On the basis of 1000 hr rupture tests the Soviets have approximately kept up with the U. S. in wrought alloys but not in casting alloys. However, the conclusion is that Soviet high-temperature alloys are the equal of U. S. alloys. (P.G.C.)

18270 MIGRATION OF POINT DEFECTS AND DISLOCATION RELAXATION IN TANTALUM. Mazzolai, Fabio Massimo; Nuovo, Mario (CNR, Rome). Ric. Sci., 36: 1131-8(Nov. 1966). (In Italian).

The reduction of intensity and temperature of dislocation relaxation, produced by heat treatments, were investigated in Ta. The experimental results showed that these effects are due to pinning of deformation-produced free dislocations by point defects. The annealing behavior mentioned agreed quantitatively with predictions of the abrupt kink model of dislocation motion proposed by Brailsford. (auth)

18271 THERMAL TENSITY IN CHROMIUM COATINGS IN MOLYBDENUM. Ivanov, V. E.; Nechiporenko, E. P.; Osipov, A. D.; Vasyutinskii, B. M.; Kartmazov, G. N. pp 77-82 of Zharostoikie Pokrytiya. Borisenko, A. I. (ed.). Leningrad and Moscow, Izdatel'stvo Nauka, 1965. (In Russian).

The temperature dependence of the chromium-coating tensities on molybdenum prepared in a vacuum and with various bonding bases was studied at about 100 to 1000°C. (R.V.J.)

18272 ELECTRICAL RESISTIVITY, THERMAL CONDUCTIVITY, AND MAGNETIC SUSCEPTIBILITY OF POLYCRYSTALLINE SAMARIUM AT LOW TEMPERATURES. Arajs, Sigurds; Dunmyre, G. R. (United States Steel Corp., Monroeville, Pa.). Z. Naturforsch., 21a: 1856-9(Nov. 1966).

Electrical resistivity, thermal conductivity, and magnetic susceptibility were measured, using the same sample of samarium, from 4 to 300°K, from 5 to 200°K, and from 4 to 300°K, respectively. Two anomalies, one at 12 ± 1°K and another at 106 ± 1°K, were observed, resulting from an order-order magnetic transformation and an antiferromagnetic-paramagnetic transition, respectively. The Lorenz function was found to be larger at any temperature than that expected for pure electronic thermal conductivity. This implies that there is some phonon and possibly also some magnon thermal conductivity in samarium at low temperatures. The magnetic moment disorder electrical resistivity of samarium was determined to be 39.0 ± 0.5 μΩ cm, in fair agreement with the value to be expected from theoretical considerations. (auth)

18273 ELASTIC PROPERTIES OF A TUNGSTEN–SILVER COMPOSITE ABOVE AND BELOW THE MELTING POINT OF SILVER. Umekawa, S. (Tokyo Inst. of Tech.); Kotfila, R.; Sherby, O. D. J. Mech. Phys. Solids, 13: 229-35(Aug. 1965).

The dynamic Young's modulus of a Ag–W composite containing 20 vol % Ag was evaluated up to 1020°C. In the temperature range from 25 to 800°C it was shown that the temperature dependence of the modulus as well as the absolute value of the modulus is closely approximated by the upper bound theory of Hashin and Shtrikman. Above 800°C the modulus decreases more rapidly than predicted by the theory, and the rapid decrease is believed to be associated with interphase boundary shearing between the W and Ag phases. A large discontinuity in modulus (over 10% change) is observed at the melting point of Ag. Above the melting point of Ag, the modulus of the composite is equal to the modulus of a W sample containing an equivalent percentage of pores. This suggests that there is no strengthening of the W from the presence of the molten Ag. (auth)

18274 PROCESS FOR IMPROVING THE MECHANICAL CHARACTERISTICS OF OBJECTS CONSISTING OF BERYYLIUM OR BERYLLIUM ALLOY. Mallen, Jose; Weisz, Michel (to Commissariat a l'Energie Atomique). British Patent 1,056,255. Jan. 25, 1967. Priority date Oct. 10, 1963, France.

A thermo-mechanical process for treatment of objects composed of Be or Be alloys consists of heating the object to a temperature (550 to 650°C) close to the recrystallization temperature of the metal or alloy, subjecting the object at that temperature to a permanent deformation that is insufficient to cause recrystallization during the period of time sufficient to release the internal stress resulting from the deformation, and then cooling the object. The deformation may be produced by traction, compression, torsion, or bending. (B.L.M.)

18275 WERWELSTROOMVERLIESE IN GADOLINIUM. (Eddy Current Losses in Gadolinium). Van Eck Oosthuizen, Casparus Petrus. Bloemfontein, South Africa, Univ. of the Orange Free State, 1964. 67p.

Thesis.

The classic theory of eddy currents is outlined. The apparatus and experimental methods used in the measurement of eddy currents in Gd are described. The results are reported and discussed. It is shown that the data obtained are not in agreement with theory. (J.S.R.)

Structure and Phase Studies

Refer also to abstracts 18232, 18250, and 18261.

18276 (CALT-221-28) DIFFRACTION CONTRAST AT PLANAR INTERFACES OF LARGE COHERENT PRECIPITATES. Ardell, A. J. (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Jan. 1967. Contract AT(04-3)-221. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Fringe contrast has been observed by transmission electron microscopy at the interfaces of large, coherent γ' precipitates in an aged Ni–6.71 wt % Al alloy. The fringes display characteristic δ-fringe symmetry; they are antisymmetrical in bright field and symmetrical in dark field. In addition, specific extinction conditions are satisfied; whenever the diffraction vector, $\vec{g}$, lies in the plane of the interface, fringe contrast vanishes at that interface. A model describing the lattice distortions near the γ'-matrix interface is considered in detail. This model is consistent with the extinction conditions and accounts for the difference

between the excitation errors of the precipitate and matrix which produces δ-fringe contrast. Also, the model correctly predicts the nature of the fringes (i.e., bright or dark) at the top and bottom of the foil. (auth)

18277 (EURAEC–1582) STUDY OF A FEW METAL OXIDATION PROBLEMS AND APPLICATION OF IMPEDENCE MEASUREMENT METHODS TO THE STUDY OF CORROSION RESISTANCE IN WATER. Quarterly Report No. 12, January 1–March 31, 1965. (Brussels Univ. (Belgium)). [1966]. Contract 012-63-10 TEEB. 10p. (EUR–2812). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Progress on a study of dry oxidation of metal surfaces under controlled conditions is reported. Current research is on single crystals of Al of known structure and orientation, to determine effects of O_2 pressure, time of exposure, temperature, and orientation of the metal on progress of nucleation. (P.G.C.)

18278 (EURAEC–1758) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 16, July 1–September 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contract 054-64-4-TEEB. 20p. (EUR–3313). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The general outlines are given of a theory explaining the appearance of satellite spots in selective area diffraction patterns of crystals containing planar interfaces such as stacking faults, antiphase boundaries, domain boundaries and grain and twin boundaries. Anomalous absorption is taken into account and the properties of the satellite spots due to stacking faults are deduced. Observations of antiphase boundaries in rutile (TiO_2) and stacking faults in stainless steel are shown with the associated diffraction patterns. The characteristics of the observed satellites are in very good agreement with the theory. A method is described for determination of the nature of stacking faults in fcc metals which is based on the geometry of the satellites in the diffraction pattern. The method requires only information from the bright-field image and from the fine structure of the diffraction pattern. (auth)

18279 (EURAEC–1801) QUARTERLY REPORT NO. 2.42 [ON STUDIES OF STEELS], OCTOBER 1–DECEMBER 31, 1966. (Chantiers de l'Atlantique Saint-Nazaire (France)). Contract 054-61-12-RDF. 4p. (EUR–3342). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

General research was continued on the austenitization of steels. For each steel tested there was a critical heating rate below which the austenitic superheating grain is hardly or not at all refined, which results in absence of regeneration after superheating. Curves were plotted, which make it possible to predict the structure and hardness of steel plates after normalization following slag welding. Systematic stress-relief research was begun on normalized steels and on normalized and tempered steels. (M.C.G.)

18280 (EURAEC–1803) RESEARCH TO DETERMINE THE LONG-TERM MECHANICAL PROPERTIES OF METALS SUBJECTED TO MECHANICAL STRESS AT ELEVATED TEMPERATURES AND NEUTRON IRRADIATION. Quarterly Report No. 15, July 1–September 30, 1966. Siegfried, W. (Battelle Memorial Inst., Geneva (Switzerland)). Jan. 1967. Contracts W-7405-eng-92; 100-62-12 RDS; 057-64-7 TEES (RD). 16p. (EUR–3344). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Analyses of isothermal time-to-rupture curves of metals, plotted at different temperatures, were used in a study of the mechanics of deformation, mechanics of separation, and of structural changes. It is postulated that time-to-rupture tests of irradiated metals may also be evaluated by this method. (P.G.C.)

18281 (INR-762/II/PS) THE DEPENDENCE OF THE CALCULATED ELASTIC CONSTANTS OF THE c/a RATIO FOR HEXAGONAL CLOSE-PACKED STRUCTURE METALS. Czachor, A.; Pindor, A. (Institute of Nuclear Research, Warsaw (Poland)). Nov. 1966. 16p. Dep.

The elastic constants for metals of hexagonal, close-packed structure were calculated, assuming coulomb-screened interaction and Born–Mayer interaction between ions. It was found, that the interactions are large enough to lead to unstability of the hexagonal, close-packed structure for the ratio of lattice parameters (c/a). (auth)

18282 (RT-MET–(66)2) FASI METASTABILI IN LEGHE DI URANIO A BASSO TENORE IN NIOBIO E LORO DECOMPOSIZIONE TERMICA. (Metastable Phases in Uranium Alloys With Low Niobium Content and Their Thermal Decomposition). Coppola, F.; Fizzotti, C. (Comitato Nazionale Energia Nucleare, Rome (Italy)). 1966. 37p. (In Italian). Dep. mn.

The metastable phases obtained in U alloys with 0.5 to 30 wt % Nb as a result of tempering in water at 900°C and the thermal decomposition of solid solutions at 400 to 625°C were studied. Microscopic examination of the metastable phases showed three diverse types of grains in the alloys. The alloys with 0.5% Nb showed grains more or less equiaxial with those found in unalloyed U. The alloys with 1 and 2% Nb showed, needle-shaped grains and the alloys with 2.5, 3, 4, and 5% Nb had band grains. The thermal stability of the needle-type structures and the band structures were determined by heating in the temperature region from 400 to 625°C. In the 1% alloy decomposition kinetics indicated three successive types of precipitation. The needle grains less rich in Nb were more stable. At higher concentrations the needle-type grains became less stable thermally and precipitation of the $\bar{\gamma}$ phase caused recrystallization in limited zones of the matrix whereas transformation of the precipitated phase completed recrystallization of the matrix. The Martensite band had similar conditions of thermal instability but in contrast to the needle-type grains the band grains recrystallized rapidly and completely in 3% alloys. A second recrystallization was also observed in these alloys. (J.S.R.)

18283 (JPRS–39757) A STUDY OF THE ISOTHERMAL SECTION AT 1200°C OF THE TERNARY SYSTEM W–Mo–Zr. Chuang, Yu-chih; Ni, Kuo-nien. Translated from Chin Shu Hsueh Pao, 9: 176-80(Apr. 1966). 10p. (TT-67-30405). CFSTI $3.00 cy, $0.65 mn.

The isothermal section at 1200°C of the ternary system W–Mo–Zr was studied by means of metallographic and x-ray analysis. It was confirmed that three very narrow single phase regions of W–Mo solid solution α, Zr solid solution β, and a ternary intermediate phase ϵ, as well as two broad binary phase regions of (α + ϵ) and (ϵ + β) exist. The α and β phases have body-centered cubic structure, while the ϵ phase has the ternary Laves $Zr(W,Mo)_2$ phase of $MgCu_2$ structure. The lattice parameter of ϵ phase varies linearly from ZrW_2 to $ZrMo_2$. The measurement of alloy hardness coincided with the results of metallographic and x-ray analysis. (auth)

18284 CRYSTAL STRUCTURE OF $Nb_2Ni_{21}B_6$. Kuz'ma, Yu. B.; Fedorov, T. F.; Sobolev, A. S.; Skolozdra, R. V. (Lvov State Univ. Baikov Inst. of Metallurgy, Moscow). Soviet Phys.-Cryst. (Engl. Transl.), 11: 697-8(Mar.-Apr. 1967).

Translated from Kristallografiya, 11: 821-2(Sept.-Oct. 1966).

Alloys of the composition $Nb_2Ni_{21}B_6$ were prepared and an x-ray structure analysis was made. The x-ray-diffraction pattern can be indexed within cubic symmetry with a unit-cell constant of a = 10.557 ± 0.005 A. Calculations based on the assumption that the structure might possibly belong to the $W_2Cr_{21}C_6$ structure type agreed well with the observed data. (A.G.W.)

18285 NEUTRON DIFFRACTION STUDIES ON MnAl, Mn_3Ni_2C, AND $MnZn_3$. Natera, M. G.; Pineda, V. Ma.; Navarro, Q. O. (Philippine Atomic Research Center, Diliman, Quezon City). Philippines Nucl. J., 1: No. 1, 23-7(July 1966).

A neutron crystal spectrometer installed at the beam port BX-6 of the Philippine Research Reactor was used in investigating the crystal and magnetic structures of MnAl, Mn_3Ni_2C, and $MnZn_3$. (auth)

18286 PHYSICS OF HIGH TEMPERATURE CREEP IN METALS. McLean, D. (National Physical Lab., Teddington, Eng.). Rep. Progr. Phys., 29: 1-33(1966).

Earlier physical studies of creep have shown that there are several different creep régimes depending mainly on the temperature. If T_M is the melting point of the metal in question, the different régimes roughly cover the temperature ranges 0 to 0.3, 0.3 to 0.5, 0.5 to 0.9, and 0.9 to 1.0 T_M. The bottom range includes the so-called logarithmic creep and the top range creep by diffusion, which is somewhat similar to flow in liquids. Various creep rate studies were made for these temperature ranges. (M.O.W.)

18287 INVESTIGATION OF ELECTRONIC STRUCTURE OF METALLIC THORIUM AND URANIUM BY MEASUREMENT OF THE ANGULAR CORRELATION OF ANNIHILATION RADIATION. Rozenfeld, Bronislaw; Szuszkiewicz, Marian (Wroclaw Univ.). Nukleonika, 11: 693-702(1966).

The angular correlation of radiation from two-photon annihilation of electron–positron pairs in metallic Th and U was measured. From the angular correlation curves the distributions of the absolute momentum values were obtained and hence the component angular distributions corresponding to particular electron

configurations. For Th, one group of hybridized s + d-conduction electrons — 4.0 ± 0.2 electrons/atom — was determined, and a subgroup of s-conduction electrons — 1.8 ± 0.2 electrons/atom — was discernible. In U two groups of conduction electrons were found having a tendency to decompose, containing together 6.0 ± 0.3 electrons/atom. One of these groups, characterized by 1.9 ± 0.2 electrons/atom should probably be ascribed to s-electrons, and the other — with 4.1 ± 0.4 electrons/atom — probably results from the hybridization of d- and f-electrons. An idealized momentum model is presented for both metals. (auth)

18288 TRANSMISSION ELECTRON MICROSCOPIC STUDIES OF UNDOPED TUNGSTEN WIRE (0.38 mmϕ) ANNEALED ISOTHERMALLY AT 1180°C. Mima, Genjiro (Osaka Univ.); Nishida, Kazuhiko. Nippon Kinzoku Gakkaishi, 30: 1047-51(1966). (In Japanese).

Changes in the configuration of dislocations of the undoped tungsten wire (0.38 mmϕ) during isothermal annealing at 1180°C were studied by transmission electron-microscope observations. Results coincide with those by optical and replica electron-microscope observations. The microstructure of the drawn-tungsten wire consisted of highly elongated grains called fibers or fiberish grains. Although characteristic boundary fringes were observed on these fiberish grain boundaries and the barreled subgrain boundaries in the annealed specimens, their boundaries did not seem to be high-angle boundaries. During isothermal annealing, the grains surrounded by high-angle boundaries were not observed, and recrystallization nuclei were not found. (auth)

18289 DEBYE–SCHERRER CHAMBER FOR THE STUDY OF X-RAY DIFFRACTION OF PREPARATIONS USED IN ELECTRON MICROSCOPY AND OTHER SAMPLES OF SMALL QUANTITY. Chaulet, Roger; Guillaumin, Jean (Societe Industrielle de Combustible Nucleaire, Veurey, France). J. Microscop., 5: 349-54(1966). (In French).

A simple device for obtaining x-ray diffraction patterns from metallurgical preparations used in micrography is described. It is a classical chamber of radius 6.5 mm with the sample mounted in the center, using standard Kodirex film. Use of the apparatus is illustrated with and without monochromator. A U-Mo alloy (1.5% Mo) was examined by both electron microscopy and by diffraction; precipitate limits, difficult to identify by microscopy, are related to phases of orthorhombic Uα and tetragonal Uγ' (U_2Mo) by x-ray diffraction, using CrKα for 20 hr. A sample of UO_2 powder was also mounted on a hair and studied with CuKα-Kβ filtered with Ni for 2½ hr with a 200 μ collimator. Results are illustrated in a plate. The method complements traditional electron micrography. (BBB)

18290 GRAIN GROWTH PHENOMENON IN ZIRCONIUM. Colin, J.-C.; Lehr, P. (CNRS, Vitry-sur-Seine, France). pp 77-96 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Grain-growth phenomena in the recrystallized state were studied in zirconium using industrially pure Kroll zirconium and very-high-purity Van Arkel zirconium. Topological relations of the metal remained unaltered during annealings despite changes in the structure. The mean diameter of the crystals increased linearly as a function of the number of their sides; the crystals were most frequently hexagonal in form. In addition there was an equilibrium relation between the frequency of crystals with more than 6 sides and that of crystals with less than 6 sides. From a statistical point of view the distribution of the grains as a function of their mean diameter approximated closely the lognormal law, when the grains were divided into categories of which the limits form a geometric progression. The variation in mean diameter was studied as a function of isothermal-annealing time. The activation heat was determined for both metals. Basic principles governing grain growth under isothermal conditions from the energy point of view are discussed. Results showed it is possible to predict theoretically the kinetic law of phenomenon; however, the theoretical value of the exponent n is 0.5, considerably higher than that determined experimentally (n = 0.25). (P.C.S.)

18291 RECRYSTALLIZATION, GRAIN GROWTH, AND PREFERENTIAL ORIENTATIONS IN ZONE MELTED ZIRCONIUM. Billion, M.; Langeron, J.-P. (CNRS, Vitry-sur-Seine, France). pp 97-105 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

High-purity Zr crystal bar was zone melted ten times under ultrahigh statical vacuum. Purified Zr recrystallized at 170 against 295°C for the starting metal and had a resistivity ratio, in the recrystallized state ($R_{H_2}/R_{ambiante}$) of 36×10^{-4}. A determination of the preferential orientation of zone-melted Zr sheets in the cold-worked state (reduction ratio of 98%) and after annealing at increasing temperatures showed that recrystallization occurs without texture modification: the Polanyi diagram in the initial sheeting state and after annealing at 200°C are the same. The texture modification accordingly does not occur during recrystallization, but during the grain growth. This growth versus annealing temperature, was followed on several samples. It does not follow a single law in all temperature fields (300 to 850°C). (auth)

18292 ZIRCONIUM ALLOYS AND THEIR TRANSFORMATIONS. Armand, M. (SECEMAE d'Ugine, Albertville, France). pp 107-21 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Conditions for fashioning sound ingots devoid of segregation of the main zirconium alloys used industrially using an arc furnace in which the electrodes are consumed under vacuum are described. Starting from considerations on the equilibrium diagrams, different aspects of the structure of these alloys, from the smelting stage to the final product, are interpreted, and an attempt is made to define the principles of their transformation at high and low temperature. The aim is to obtain in the finished products a fine-grained structure, stable under the conditions of use, with scattered and properly distributed precipitates. (auth)

18293 ZIRCONIUM THIN FILM OBSERVATIONS BY TRANSMISSION ELECTRON MICROSCOPY; STUDY OF PLASTIC DEFORMATION. Pollard, J.; Rzepski, J.; Lehr, P. (CNRS, Vitry-sur-Seine, France). pp 123-33 of Etude sur la Corrosion et la Protection du Zirconium et de ses Alliages. Saleese, M.; Chaudron, G. Gif-sur-Yvette, France, Centre d'Etudes Nucleaires de Saclay, 1966 and Paris, Presses Universitaires de France, 1966. (In French).

Monocrystal studies on high-purity and industrial-purity zirconium showed that deformation takes place essentially by slipping along the $(10\bar{1}0)$ prism planes in the $(12\bar{1}0)$ type directions of slip. In additions zirconium presents modes of deformation by twinning of the type $(10\bar{1}2)$, $(11\bar{2}1)$, and $11\bar{2}2)$ etc... the first two types of twinning being the most important. (auth)

Radiation Effects

Refer also to abstracts 18218, 18255, and 18824.

18294 (AD–642408) INTERACTIONS OF ACTIVATED GASES WITH SOLIDS. Final Scientific Report, October 1, 1961–June 1966. Donaldson, Edward E. (Washington State Univ., Pullman. Dept. of Physics). Nov. 18, 1966. Contracts AF-AFOSR-62-86; AF-AFOSR-551-64. 9p. (AFOSR–66–2673). CFSTI $3.00 cy, $0.65 mn.

In investigations of the adsorption of nitrogen on solid surfaces, it was found that when nitrogen molecules are either bombarded by electrons or when they encounter an incandescent metal surface, atoms of nitrogen may be produced which sorb much more readily than the parent molecule. Thus the activated state was shown to be atomic. Burial of argon ions in nickel was studied. It was learned that the sticking probability for these ions depends upon whether the nickel surface is in a cold-worked or an annealed condition (highest sticking probability in cold-worked nickel). This suggests that either grain boundaries or dislocations may provide sites for adsorption but neither possibility can yet be eliminated. Desorption by photons, electrons, and ions was observed. Photon and electron bombardment desorption studies demonstrated that desorption occurs by way of an intermediate activated surface state while ion bombardment desorption was observed only as a secondary process in ion burial studies. Desorption by thermal means permitted the determination of energy with which ions are bound in the metal. (auth)

18295 (BNWL–361) NEUTRON IRRADIATION EFFECTS IN FCC, BCC, AND CPH METALS. Brimhall, J. L.; Mastel, B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1967. Contract AT(45-1)-1830. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A brief review of radiation effects on crystal structure of Mo, Ni, and Re is given. Specimens were irradiated under identical flux and temperature conditions, and comparison of the damage state was made as a function of total-exposure, irradiation temperature, and post-irradiation annealing treatment. (P.G.C.)

18296 (CONF-660627-14) INFLUENCE OF BORON ON THE CREEP-RUPTURE PROPERTIES OF A NEUTRON IRRADIATED PRECIPITATION HARDENING IRON BASE ALLOY. Moteff, J.;

Lovell, A. J.; Kingsbury, F. D.; Smith, J. P. (General Electric Co., Cincinnati, Ohio. Nuclear Materials and Propulsion Operation). [1966]. Contract AT(40-1)-2847. 62p. (GE-TM-66-6-15). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Society for Testing and Materials, 69th Annual Meeting, Atlantic City.

The 650°C stress-rupture strength and ductility of an Fe-base precipitation-hardening alloy (A-286) have been found to be appreciably reduced by neutron irradiation in the neutron fluence range 1.8 to 6.5×10^{20} nvt (thermal) and 4.8 to 7.2×10^{19} nvt ($E_n \geq 1$ MeV). The loss in stress-rupture strength of irradiated A-286 alloy was found to be proportional to the fast neutron fluence level. The loss in stress-rupture strength became greater for those specimens containing the least amount of B. However, the strength of irradiated specimens containing the greater amount of B does show a decrease at the higher fluence level (7.2×10^{19} nvt). The loss in stress-rupture strength of this (A-286) precipitation-hardening alloy was not directly related to the increase in He concentration (i.e., product of B concentration and thermal neutron fluence level) as has been observed to occur in some of the other high-temperature alloys for these test conditions. (P.C.H.)

18297 (EURAEC-1614) INFLUENCE OF NITROGEN IN IRON AND STEEL UNDER FAST NEUTRON IRRADIATION. Final Report. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Feb. 1966. Contract 004-63-10-TEEI(RD). 356p. (EUR-2827; M-402). DTIE.

Work Performed under United States–Euratom Joint Research and Development Program.

The final report on research to determine the nature of defects produced by fast neutron irradiation in pure iron and medium C steels, used in pressure vessels, is presented. Emphasis is given to the effects of N, and experiments show that part of the damage produced by fast neutrons is due to point defects. The nature of radiation damage was determined by magnetic viscosity experiments, and the conditions of interstitials, their interactions with substitutional atoms, and with dislocations were studied by internal friction methods. Descriptions of analytical methods, facilities and apparatus used in the research are given. (P.G.C.)

18298 (EURAEC-1652) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 3, September 1–November 30, 1965. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). Contract 055-65-3TEEB(RD). 18p. (EUR-2850; R-2375). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Stainless steel specimens in contact with water or gas were irradiated up to 2×10^{15} nvt at room temperature. Oxide characteristics were determined by coulometric reduction and compared with unirradiated specimens. Oxide films on non-irradiated stainless steels showed a fine-grained layer with an alpha Fe_2O_3 structure before reduction and an amorphous layer after it. No indication of passivation was found. (P.G.C.)

18299 (EURAEC-1794) A NEW DETERMINATION OF THE EMBRITTLEMENT IN STEEL USING SMALL SPECIMENS (≈0.2 cc) IN PARTICULAR WITH RESPECT TO IRRADIATION. (Progress Report M 67-71-50005. Results of Work Performed Between October 1-December 31, 1966. van Elst, H. C. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Delft). Jan. 20, 1967. Contract 060-64-11-TEEN. 36p. (EUR-3334). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

Determination of the embrittlement of 4 pressure vessel steels (Soudotenax 58, HSB 55 C, 1.2 MD 07, T_1) after increasing neutron radiation fluences between ca 1×10^{18} and ca 0.5×10^{21} n × cm^{-2} at 80 degrees centigrade by performance of the stress wave attenuation test was completed. The increase in arrest temperature, according to the results of this test, using several criteria for indicating the transition temperature, was evaluated. This increase of the arrest (transition) temperature at the highest neutron fluence was different for the different steels (it varied between ca 50 and 100 degrees centigrade); its tendency towards saturation depended on the steel. A comparison with available notch impact tests from investigations of the RCN-Petten, Netherlands, was possible for two steels (1.2 MD 07 and T_1). The tendency towards saturation in the increase of the arrest (transition) temperature was more pronounced in the results of the stress wave attenuation tests than in that of these notch impact tests. Consequently, the prediction of this increase according to the first test, became smaller at the higher neutron fluence values than according to the second test. (auth)

18300 (GA-7618) A RESEARCH PROGRAM ON THE EFFECT OF SUBSTRUCTURE ON THE IRRADIATION STABILITY OF ASTM A302 GRADE B STEEL. Quarterly Progress Report No. 7. Trozera, T. A.; Flynn, P. W. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Jan. 20, 1967. Contract AT(04-3)-167. 14p. (EURAEC-1807). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The ambient temperature irradiation capsules have been assembled and irradiated or are awaiting insertion. Heater performance and temperature in a section of the elevated temperature capsule were checked. The NDT shift for warm-worked A302-B steel was found to be in excess of 200°C. Electron transmission microscope examination of quenched and tempered and two cold-worked and heat-treated conditions has not revealed observable differences in structure. (auth)

18301 (IN-1048) NUCLEAR TECHNOLOGY BRANCHES QUARTERLY REPORT, JULY 1–SEPTEMBER 30, 1966. (Idaho Nuclear Corp., Idaho Falls). Feb. 1967. Contract AT(10-1)-1230. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Values for β/Λ obtained recently in the ATRC using reactor noise techniques are reported, and the procedures for data analysis currently in use are described. Effects of flux trap experiments and outer shim positions on the ATRC power distribution are described. The importance of motion of ATR fuel assemblies induced by the operating conditions was evaluated. Although significant motion was calculated, the geometrical changes that result do not appear detrimental. Hydraulic testing of production ATR fuel elements was continued. Inadequate roll-swage-joint strength appears to be the cause of the premature failure of one fuel assembly. From a study of the physical, chemical, and metallurgical changes which take place in various fuel systems during irradiation, some of the fuel stability variables which reduce uniform fission product swelling and lower the accelerated swelling threshold temperature have been identified. Large differences in uniform swelling rates and in accelerated swelling temperatures from one system to the next suggest that control of these variables could result in greater fuel stability. The incorporation of initial porosity to accommodate uniform swelling from fission improves the irradiation performance of aluminum plate-type elements. Type 2219 aluminum alloy clad fuel plates have been corrosion tested in-pile under ATR conditions. Type 2219 aluminum in both the annealed (–0) and precipitation-hardened (T-62) condition appears superior to Type 6061-0 aluminum for application in the ATR. UAl alloys and intermetallics appear to be compatible with liquid lead for short periods (≈72 hours) at 600°C. For longer periods, varying reaction and lead penetration occur. (auth)

18302 (IN-1057) GAS RELEASE AND COMPRESSION PROPERTIES IN BERYLLIUM IRRADIATED AT 600 AND 750°C. Beeston, J. M. (Idaho Nuclear Corp., Idaho Falls). Feb. 1967. Contract AT(10-1)-1230. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

He released from Be irradiated at 600 and 750°C was measured and related to a macro-diffusion coefficient, D. The value of D at 600°C was 6.8×10^{-14} and at 750°C was 1.13×10^{-9} cc/sec. The magnitude of the macro-diffusion coefficient at 750°C agrees with that predicted for gas diffusion in Be, but at 600°C agrees better with the self-diffusion coefficient. The activation energy, G, for release of He in the equation $D = D_0 \exp[(-G/k\ T)]$ is then 5 eV, which corresponds to the activation energy for re-solution processes. The recoil mechanism for He release was considered and was shown to be small when appreciable gas was released from the samples. The microstructure of the Be showed larger gas-bubble formation in the grain boundaries than within the grains. The compression yield strength of the Be irradiated to 1×10^{21} n/cc E > 1 MeV at these temperatures increased only slightly, and although appreciable plastic deformation was sustained in the compression testing, the ultimate compression strength decreased. (auth)

18303 (UCID-4544) RADIATION EFFECTS ON ELECTRONIC COMPONENTS. Laine, E. F. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 1, 1962. Contract W-7405-eng-48. 71p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Summaries of the effects of nuclear radiation upon a wide variety of electronic materials and equipment are presented. Topics include effects on metals, ceramics, plastics, adhesives, elastomers, hydraulic fluids, cables, capacitors, insulators, resistors, and vacuum tubes. Radiation dosage standards are given as are equations for γ dose conversions. (P.G.C.)

18304 INVESTIGATION OF ZONES DAMAGED BY FRAGMENTS OF HEAVY NUCLEI FISSION. Gorshkov, V. K.; L'vov, L. N.; Petrov, P. A. At. Energ. (USSR), 22: 24-7(Jan. 1967). (In Russian).

A study was made to determine the basis of the established

anomalous decrease of evaporation velocity of thin sources containing ^{244}Cm. It was shown that the anomaly is produced by a local damage to the surface by fission fragments. The mean diameter of the local zone depends on the pressure of the medium in which the source is located and is equal to 0.1 to 1 mk. (tr-auth)

18305 PHASE CHANGE AND DISORDER PRODUCTION BY IRRADIATION OF U_2Ti. Bloch, J. (CEA, Fontenau-aux-Roses, France). Bull. Soc. Sci. Bretagne, 39: 141-6(1964). (In French).

The phase change and disorder production was studied in a U–Ti alloy containing 35 at. % Ti, a composition that yields an alloy consisting essentially of the phase U_2Ti. The samples were exposed to reactor irradiation and a crystallographic analysis was made. The results indicated that in the U–Ti alloy a cubic and a hexagonal phase coexist. The role of collisions is predominant as they produce the disorder point by point. The parameters are altered progressively by the remote stresses created by atoms in a poor position in the lattice. (J.S.R.)

18306 IMPROVEMENTS IN OR RELATING TO TREATMENT OF METALS. Pfeil, Peter Charles Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,055,318. Jan. 18, 1967. Filed Oct. 12, 1964.

A method for reducing the effect of irradiation on essentially B-free stainless steels and Ni-plated alloys comprises adding to the alloy a quantity of ^{11}B in the proportions of 5 to 200 ppM by weight. The metal is then heat treated at 900°C and cooled slowly. The alloy may also contain up to 0.2 wt % Zr and 0.07 to 0.13 wt % C. (B.L.M.)

18307 IMPROVEMENTS IN OR RELATING TO HEAT TREATMENT OF STEEL. Pfeil, Peter Charles Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,055,317. Jan. 18, 1967. Filed Apr. 10, 1963.

A heat-treatment method is described for improving the high-temperature ductility after irradiation of austenitic stainless steel. The metal is worked, annealed at a temperature in the range from 800 to 900°C, and the working-annealing process repeated at least once to allow the coarsening or formation and coarsening of a precipitate of all the material that is insoluble at the temperature of the anneal and that would otherwise form a fine precipitate under irradiation conditions. (B.L.M.)

Ceramics and Cermets

Refer also to abstract 19152.

18308 (BMI-1784) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING JULY THROUGH SEPTEMBER 1966. Keller, Donald L. (Battelle Memorial Inst., Columbus, Ohio). Oct. 1, 1966. Contract W-7405-eng-92. 56p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The following topics are covered: UN–PuN fuel materials, irradiation effects on reactor cladding materials, coated-particle fuel materials (ceramic-coated Pu–base), pyrolytic C-coated UN, and graphite coatings), development of $BeO-ThO_2-PuO_2$ fuels for gas-cooled reactors, UO_2-PuO_2 fuel development, and effects of high burnup on UO_2-CeO_2 and UO_2-ZrO_2 fuels. (D.L.C.)

Corrosion and Erosion

Refer also to abstract 18215.

18309 GAS EROSION OF REFRACTORY MATERIALS WITH ZIRCONIUM DIOXIDE BASE. I. REFRACTORY MATERIALS IN THE FLOW OF COMBUSTION PRODUCTS. Abraitis, R.; Majauskas, J. Lietuvos TSR Mokslu Akad. Darbai, Ser. B, No. 3, 141-9(1966). (In Russian).

A method was developed for studying the erosion resistance of high-temperature oxides very sensitive to thermal impact. The rate of erosion of refractory materials with ZrO_2 base was studied as a function of test duration, temperature, and the high-temperature current rate. During the first 2 to 3 hr of tests at 2320°K and at a current rate of about 500 m/sec an intensive change took place in the surface in close contact with the high-temperature gas current. During that period the rate of erosion slowed down by 3 to 4 times and slowly became static. During the following 3 to 6 hr it remained constant. With an increase of the specimen wall temperature from 2000 to 2630°K the rate of erosion increased and with increases in the high-temperature current rate from 370 to 730 m/sec the weight losses increased considerably. The numerical magnitudes of erosion rate are a function of the composition of materials. (R.V.J.)

18310 A METHOD OF INHIBITING THE CORROSION OF GRAPHITE IN NUCLEAR REACTORS. Koch, Charles; Merle, Andree (to Commissariat a l'Energie Atomique). British Patent 1,057,604. Feb. 1, 1967. Priority date Oct. 1, 1964, France.

The addition of an organic inhibitor selected from the group consisting of aldehydes, ketones, and organic acids to the CO_2 cooling gas of a graphite-moderated, gas-cooled reactor was found to inhibit the corrosion of the graphite. The inhibitor must be gaseous at the operating temperature of the reactor. Also, a light hydrocarbon, methane, ethylene, or benzene added to the inhibitor was found to increase its efficiency. (B.L.M.)

Preparation and Fabrication

18311 (CEND-2863-243) THE DEVELOPMENT AND TESTING OF UO_2 FUEL SYSTEMS FOR WATER REACTOR APPLICATIONS. Final Summary Report, July 1, 1961–June 30, 1965. Chernock, W. P.; Anthony, A. J.; Burdg, C. E.; Koziol, J. J.; Mordarski, W. J.; Veil, E. I.; Zuromsky, G. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Nov. 1965. Contract AT(30-1)-2863. 220p. (EURAEC-1543). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Developments are reported for powder compaction, thermal performance characteristics of UO_2, collapse criteria, and projection welding. The objective of the program on powder compaction was the reduction in overall fuel cycle costs for fuel elements containing UO_2. The results of compaction methods evaluated are described. The thermal conductivity of UO_2 (at 93.5% theoretical density) was determined for temperatures up to 2200°C using a high thermal gradicnt radial heat flow technique. The best value for the thermal conductivity of stoichiometric UO_2 (uncorrected for density) was determined to be 0.033 watts/cm°C at 1000°C and decreased to a value of 0.024 watts/cm-°C at approximately 1700°C. It was concluded that out-of-pile measurements of thermal conductivity made under high thermal gradient conditions can be used as an effective measure of short-term, in-reactor conductivities. The evaluation of fuel supported cladding indicated 0.010 in. wall annealed stainless steel can be used as a clad over 0.500 in. dia pelletized UO_2 fuel. However, the diametrical clearance between the fuel and the clad must not exceed 0.004 in. Vibratory compacted UO_2 powder of 86% theoretical density or greater provides sufficient fuel support to prevent any deformation of 0.500 in. dia, 0.010 in. wall tube samples at 5000 psi external pressure. A method was developed for fabricating stainless steel and Zircaloy clad fuel rod clusters by projection welding spacer wires between rows of filled or empty fuel rods. Electrode tooling and cluster fixturing were developed for the production of square or hexagonal arrays of seven foot long stainless steel clusters containing up to 61 tubes and for small Zircaloy assemblies. (P.C.H.)

18312 A REFRACTORY MATERIAL RESISTING THERMAL SHOCK: IMPREGNATED TANTALUM CARBIDE. Hivert, A. Ann. Mines, 941-54(Oct.-Nov. 1966). (In French).

An improved TaC cermet was developed which embodies impregnation of porous TaC with Au or Cu. The material has resistance to thermal shock and high mechanical strength up to 3200°C. (P.G.C.)

18313 PRODUCTION OF BERYLLIUM HYDROXIDE. Morana, Simon J.; Simons, Gordon F.; Wummer, Carl J. (to The Beryllium Corp.). British Patent 1,056,825. Feb. 1, 1967. Filed Oct. 28, 1963.

An improved process for production of high-purity $Be(OH)_2$ for use in preparation of Be is described. Chelating agents are used to remove impurities other than SiO_2 and alkaline earth metals from commercial grade $Be(OH)_2$. (P.G.C.)

18314 PROCESS FOR THE FUSION OF MATERIALS AND DEVICE FOR CARRYING THE SAID PROCESS INTO EFFECT. Gayet, Bernard; Holder, Jean; Kurka, Gerard; Rebouk, Jean; Trouve, Jean (to Commissariat a l'Energie Atomique). British Patent 1,054,815. Jan. 11, 1967. Priority date Jan. 31, 1963, France.

A process is described for the induction fusion of refractory materials, such as oxides, carbides, nitrides, and metal silicides having a fusion temperature of at least 1900°C and, at the fusion point, a thermal conductivity that is less than 0.05 cal/sec/°C/cm and an electrical resistivity at most equal to 100 ohms-cm^2/cm and preferably between 100 and 0.001 ohms-cm^2/cm. The compound is converted into a cylindrical shape; a part of the sample is preheated to a temperature at least close to the melting point; and a hf current is then passed through an induction coil located about the sample. The frequency of the current is such that the ratio between the radius of the sample and the depth of penetration of the current into the sample is at least equal to 1.5 and preferably is between 1.5 and 3. (B.L.M.)

18315 HIGH STRENGTH STRUCTURES COMPRISING FIBRES OF BORON OR BORIDES. (to Texaco Experiment Inc.). British Patent 1,051,883. Dec. 21, 1966. Priority date June 4, 1962, United States.

Composite structures consisting of filaments of boron or of a refractory boride embedded in a matrix material are described. The matrix material may be an organic condensation polymer, a solidified epoxy resin, or an inorganic substance. The refractory filaments are produced by passing an elongated substrate at a substantially constant speed through an ambient gaseous composition containing a vaporizable compound of boron while maintaining the substrate at a temperature effective to cause the decomposition of boron on the substrate. X-ray diffraction data indicate that the boron combines with the substrate to form borides. (B.L.M.)

18316 SUBSTANTIALLY ISOTROPIC GRAPHITIZED BODIES USED IN NUCLEAR REACTORS. (to Great Lakes Carbon Corp.). British Patent 1,054,961. Jan. 11, 1967. Priority date Mar. 18, 1963, United States.

A method is described for the preparation of massive isotropic graphitized bodies suitable for use in reactors at temperatures in excess of 500°C when exposed to neutron flux. The arrangement of the crystallites in the bodies is highly disoriented and disordered. The bodies are prepared from graphite derived from uintaite. The bodies are characterized by having coefficients of thermal expansion in any direction of at least 30×10^{-7} in./in./°C measured at 20 to 100°C and, the coefficients in any direction do not differ in numerical value by more than 25%. (B.L.M.)

18317 SUBSTANTIALLY ISOTROPIC GRAPHITIZED BODIES USED IN NUCLEAR REACTORS. (to Great Lakes Carbon Corp.). British Patent 1,058,315. Feb. 8, 1967. Priority date Mar. 18, 1963, United States.

A method described for the production of massive isotropic graphitized bodies having good dimensional properties under irradiation conditions for use in nuclear reactors consists of preparing the bodies in such a manner that the arrangement of the crystallites is in a highly disordered, disoriented state. The bodies are prepared by mixing petroleum and/or coal tar cokes with a plasticizing agent and then heat treating the mixture in any of several manners that are described in detail. The graphitized bodies have coefficients of thermal expansion in any direction of at least 30×10^{-7} in./in.°C at 20 to 100°C, and the coefficients do not differ in any direction by more than 25%. (B.L.M.)

18318 NUCLEAR REACTOR FUEL ELEMENTS. Ford, Lionel Houston; Ingleby, Bryan Edward; Hibbert, Neil Silva (to United Kingdom Atomic Energy Authority). U. S. Patent 3,284,549. Nov. 8, 1966. Priority date Dec. 31, 1963, Great Britain.

A method is described for producing high integrity spheroids of UC having an outer coating of a substantially impermeable refractory material for use in dispersion type reactor fuel elements. An initial coating of pyrolytic C, 5 to 20 μ in thickness is deposited on spheroids of UC at a deposition temperature in the range of 1200 to 1400°C in such a manner that the reaction between the applied coating and the carbide does not take place by a substantial amount. An outer coating of a refractory material of the group consisting of pyrolytic C or SiC is applied at a temperature in the range of 1500 to 1800°C in such a manner that the reaction between the initial pyrolytic C coating and the monocarbide takes place to produce UC_2 so that voidage in the form of a gap is produced between the spheroids and the outer refractory coating. The voidage that is produced is from $\frac{1}{10}$ to $\frac{1}{3}$ of the volume of the contained spheroids. (B.L.M.)

18319 COATED ARTICLES. (to United Kingdom Atomic Energy Authority). British Patent 1,055,232. Jan. 18, 1967. Priority date Jan. 25, 1963, Belgium.

A process is described for the fabrication of coated articles composed of an inner kernel and a double coating of pyrolytic graphite, the inner graphite coating being less dense than the exterior coating. The process is particularly applicable to the coating of nuclear fuel particles, such as Th or U oxides, in that the double coating prevents migration of fuel through the coating. The particles are coated initially by reaction in a fluidized bed with a stream of hydrocarbon passed through the bed heated to a temperature of 1300°C. The second coating is applied while the particles are heated to 1700°C by passing methane through the fluidized particles. (B.L.M.)

18320 SPHERICAL PARTICLES FOR USE IN NUCLEAR FUEL ELEMENTS AND A PROCESS FOR PRODUCING THEM. (to Minnesota Mining and Manufacturing Co.). British Patent 1,054,783. Jan. 11, 1967. Priority date June 25, 1962, United States.

Spherical U-containing particles are prepared by melting a fusible solvated U salt having an anion that is removable to convert the U salt to UO_3, dispersing the molten salt in an inert medium to form substantially spherical particles from 10 to 500 μ in diameter, solidifying the particles in spherical form, and heating the solidified particles under conditions of temperature and pressure such that the particles will not melt to remove the solvent of solvation and convert the U salt to UO_3. If the fusible solvated U salt contains a nuclear fuel ingredient in the molten mixture, the process is applicable to the fabrication of spherical fuel particles for dispersion in some matrix. (B.L.M.)

Properties Evaluations

Refer also to abstract 18818.

18321 (AECL-2602) WEAR RATES OF METALS AND OXIDES IN 80 AND 160°F HIGH PURITY WATER. Dunn, J. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). Aug. 1966. 78p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $2.00.

The wear rates of 157 material combinations were determined as $\frac{3}{4}$ in. I. D. × $\frac{3}{4}$ in. long sleeve bearings in 80 and 160°F high purity pH 7 water under loads of 20 to 250 lbs at speeds of 20 to 280 rev/min for periods of 4 to 14 days. These wear results were reported as a volume rate of wear, called specific wear, which can be used directly with the load, size, and expected life of sliding contacts to predict the approximate depth of wear. The specific wear of materials evaluated ranged from 0.3 to 12,000 and the best materials (those with low specific wear) were the AECL developed hard oxides on Zr alloys and on a proprietary Ni–Sn–Bi. In over half of the tests run the wear rates decreased with increasing sliding distance. To numerically describe this wear-in behavior a wear-in factor was defined which indicates the rate of change of wear rate with distance. This wear-in effect was a function of speed and load and it was felt to be due to the gradual build-up of hydrodynamic thin film lubrication in the bearing wear scar. (auth)

18322 (ARL-66-0220) THE ELECTRICAL BEHAVIOR OF REFRACTORY OXIDES. IV. Interim Technical Report, June 1, 1965–August 15, 1966. Vest, R. W.; Tripp, W. C. (Systems Research Labs., Inc., Dayton, Ohio). Nov. 1966. Contract AF 33-(615)-2765. 77p.

Studies were made on charge and mass transport mechanisms in refractory metal oxides. Special research apparatus and instrumentation was developed in order to carry out the experimental program. The results of a study of the defect structure of Y_2O_3 and HfO_2 are reported. Measurable weight changes were observed in HfO_2 enabling an estimate of the mobility and the energy of motion, as well as the concentration of the defect, to be made. Some thermoluminescence results obtained on Y_2O_3 single crystals are reported. A procedure is described for preparing thin foils for transmission electron microscopy which combines the best features of several well known techniques. (auth)

18323 (INR-751/XIV/PR) POWDER DISPERSION MATERIALS FOR REACTOR PHYSICS MEASUREMENT. Rutkowski, W.; Szteke, W. (Institute of Nuclear Research, Warsaw (Poland)). Sept. 1966. 19p. Dep.

Techniques used to prepare dispersions of Dy_2O_3, Lu_2O_3, and H_3BO_3 in metals for measurement of neutron density and neutron spectral distribution are reported. (P.G.C.)

18324 (NASA-SP-5060) SOME NEW METAL AND METAL-CERAMIC COMPOSITES. Korman, Samuel (RAI Research Corp., Long Island City, N. Y.). 1966. 25p. GPO $0.25.

The need for rational design of composites for structural application is discussed, along with dispersion-strengthened, fiber-matrix, and reinforced ceramic systems. Some representative applications for composites and various constituents are also briefly discussed. (P.C.H.)

18325 ON THE QUESTION OF THE INFLUENCE OF THE AVERAGE GRAIN SIZE OF WC AND THE CONTENT OF THE BINDING COBALT PHASE ON X-RAY MEASUREMENTS OF MACROSTRESSES IN SINTERED CARBIDES OF THE SYSTEM WC–Co. Kraus, I. (Czech Technical Univ., Prague). Czech. J. Phys., B17: 249-58(1967). (In Russian).

The influence of the mean grain size of WC (in a range of 1 to 3 μm) and the influence of the amount of Co binding agent (6 to 25% weight) in hard metals on the x-ray determination of elastic macrostresses caused by deflection were studied. A confrontation of the results of x-ray measurements with the values of stresses calculated theoretically from the corresponding deflections and mean elastic constants showed that the values of the stresses determined by x-ray are systematically lower than those calculated theoretically and this difference is greater the larger the mean

grain size of WC and thus the larger the ratio of the binding Co. (auth)

18326 USE OF BORON COMPOUNDS IN GAS-COOLED HIGH-TEMPERATURE REACTORS. I. DETERMINATION OF THE THERMAL BEHAVIOR OF BORON IN GRAPHITE WITH THE HELP OF EMISSION SPECTROSCOPY. Nickel, H. (Kernforschungsanlage, Juelich, Ger.). Z. Anal. Chem., 225: 324-41 (1967). (In German).

The thermal behavior of B and B_4C in graphite when heated in a dc arc between graphite electrodes was studied. It was found by emission spectroscopy that in boron-containing graphite electrodes the B migrated always toward the hottest spot. The rate of this migration depends on the nature of the B-compound as well as on the degree of graphitization and the density of the graphite matrix. A possible diffusion mechanism is proposed. (auth)

18327 CONDUCTIVITY AND HALL EFFECT IN CERIUM DIHYDRIDE. Heckman, Richard C. (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 46: 2158-61(Mar. 15, 1967).

Results are given of measurements of the conductivity and Hall coefficient of CeH_2 at 200°C as functions of composition. The conductivity, in agreement with earlier results, decreases with increasing H-to-Ce ratio. The Hall coefficient is positive and increases with H additions. The results are in agreement with a model in which H is assumed to be protonic. They are not compatible with the assumption of anionic H. (auth)

18328 NATURE OF HEAT CONDUCTIVITY OF CARBIDES OF SOME TRANSITION METALS OF GROUPS IV AND V. Paderno, Yu. B.; Andreeva, T. V.; Barantseva, I. G.; Goryachev, Yu. M. (Inst. of Problems in Materials Management, Academy of Sciences, Ukrainian SSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 60-4(Feb. 1967). (In Russian).

Methods of estimating the character of scattering and Fermi energy by the temperature dependences of ρ and α were studied. Estimations of r, μ^*, m_0 U for ZrC and NbC were made over the range from 1370 to 1870°K. It is shown that increases in carbide heat conductivity with increases in temperature are determined by the decrease of the effective mass of the free carriers. A scheme of the zone structure and its temperature change, illustrating the determined regularity, is proposed. (auth)

18329 PROPERTIES OF PYROLYTIC CARBIDES AND NITRIDES. Neshpor, V. S.; Davydov, V. S.; Ermakov, B. G.; Mogilevich, B. B. (Inst. of Applied Chemistry, Leningrad). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 65-9(Feb. 1967). (In Russian).

Tabulated data are given on the chemical composition microhardness and specific electric resistance of pyrolytic TiC, ZrC, TiN, ZrN, and HfN. Data indicated that the electric conductivity of ZrC and TiC was considerably higher and ZrN and TiN lower than reported in published literature. Investigations of the temperature dependence of specific electric resistance of ZrC, ZrN, and TiN at 20 to 2000°C showed a positive temperature coefficient of specific resistance. Experiments also showed that ZrC has a diamagnetic susceptibility, with mass susceptibility $(-0.22 \pm 0.01) \times 10^{-6}$ CGSM/g, while ZrN and TiN have a paramagnetic susceptibility increasing with diminishing nitrogen content. (R.V.J.)

18330 SOME PHYSICAL PROPERTIES OF ALLOYS OF THE ZrC–NbC AND TaC–HfC SYSTEMS. Barantseva, I. G.; Paderno, V. N.; Paderno, Yu. B. (Inst. of Problems in Materials Management, Academy of Sciences, Ukrainian SSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 70-3(Feb. 1967). (In Russian).

Resistivity and Hall's constants of the alloys of ZrC–NbC and TaC–HfC systems at room temperatures were investigated. Maxima were found on the curves of the dependence of the properties on the ratio of the carbide components. An interpretation of the observed dependencies is proposed. (auth)

18331 CALCULATION OF REDUCED THERMODYNAMIC POTENTIALS OF SOME CARBIDES AND NITRIDES. Voitovich, R. F. (Inst. of Problems in Materials Management, Academy of Sciences, Ukrainian SSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 40-3(Feb. 1967). (In Russian).

Reduced thermodynamic potentials of some carbides and nitrides at temperatures of 298, 500, 1000, 1500, and 2000°K are calculated. (auth)

18332 STABILITY OF REFRACTORY COMPOUNDS IN FUSED BASALT. Burykina, A. L.; Struk, L. I., Manzhurnet, K. V. (Inst. of Problems in Materials Management, Academy of Sciences, Ukrainian, SSR). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 47-9(Feb. 1967). (In Russian).

Interaction of TiC, ZrC, NbC, MoC, and WC; AlN, ZrN, and Si_3N_4; TiB_2, ZrB_2, CrB, and MoB borides; $MoSi_2$; Cr_2O_3; and refractories on a Si_3N_4 base and SiC with a basalt melt at a temperature of 1400°C was investigated. A material ($MoSi_2$) was found, which is stable in basalt. (auth)

18333 ZHAROSTOIKIE POKRYTIYA. TRUDY SEMINARA PO ZHAROSTOIKIM POKRYTIYAM, LENINGRAD, 26–28 MAYA 1964. (Heat Resistant Coatings. Transactions of Seminar on Heat Resistant Coatings, Leningrad, May 26–28, 1964). Borisenko, A. I. (ed.). Leningrad and Moscow, Izdatel'stvo Nauka, 1965. 235p.

Twenty-four articles are included on heat-resistant coatings. A brief review is given on the physico-chemical principles of preparation of heat-resistant inorganic coatings. Silicide and gaseous protective coatings, vitreous-ceramic, galvanic, chromium, organic silicates, silicon, and other coating materials are discussed. Separate abstracts were prepared for 2 articles. (R.V.J.)

For abstracts of individual papers see: 18238 and 18271.

18334 ELASTICITY AND ANELASTICITY OF URANIUM OXIDES AT ROOM TEMPERATURE. I. STOICHIOMETRIC OXIDE. Forlano, Robert J.; Allen, A. W.; Beals, R. J. (Univ. of Illinois, Urbana. Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 50: 93-6(Feb. 21, 1967).

The elastic modulus and internal friction of stoichiometric uranium oxide at room temperature were studied using a dynamic method. The elastic modulus of stoichiometric urania at room temperature increased with increasing density. When the volume-fraction porosity was <0.1, either linear or exponential equations were used to calculate the elastic modulus as a function of density. When the volume fraction porosity was >0.1, a linear equation was more suitable. The elastic modulus of stoichiometric nonporous uranium oxide at room temperature was found, by extrapolation, to be 2243.56 ± 22.1 kbars when the exponential equation was used, and 2233.85 ± 22.05 kbars when the linear expression was used. The internal friction of stoichiometric urania decreased sharply as the grains became larger. The number, size, and position of pores were found to affect the internal friction values. (auth)

18335 MAGNETIC AND CRYSTAL STRUCTURES OF CeC_2, PrC_2, NdC_2, TbC_2, AND HoC_2 AT LOW TEMPERATURES. Atoji, M. (Argonne National Lab., Ill.). J. Chem. Phys., 46: 1891-1901(Mar. 1, 1967).

The light rare-earth dicarbides, CeC_2, PrC_2, and NdC_2, having the tetragonal CaC_2-type structure, have been shown by neutron diffraction to become a body-centered first-kind antiferromagnet with the Néel temperatures of 33°, 15°, and 29°K and with the ordered moments being 81%, 44%, and 90% of the free-ion values, respectively. The moment direction is parallel to the c axis in the above compounds. The isostructural heavy rare-earth dicarbides, TbC_2 and HoC_2, exhibit an antiferromagnetic, elliptic-helical spin alignment propagating along the a axis with the repetition quadrupole of the atomic spacing, where the Néel temperatures are 66° and 26°K, and the root-mean-square ordered moments are 5.1 and 6.9 Bohr magnetons, respectively. Here, the moments lie on the bc plane. A modulation of the above structure takes place below 40° and 16°K, with the maximum possible additional moments of 0.54 and 1.65 Bohr magnetons at 2°K in TbC_2 and HoC_2, respectively. In TbC_2, another complex magnetic structure coexists below ~33°K. Also presented are discussions on the wavy diffuse backgrounds of TbC_2 and HoC_2 at temperatures down to 2°K and the low-temperature crystallographic parameters. (auth)

18336 HIGH-TEMPERATURE THERMAL EXPANSION OF CERTAIN GROUP IV AND GROUP V DIBORIDES. Keihn, F. G.; Keplin, E. J. (Union Carbide Research Inst., Tarrytown, N. Y.). J. Amer. Ceram. Soc., 50: 81-4(Feb. 21, 1967).

The thermal expansions of TiB_2, ZrB_2, HfB_2, NbB_2, and TaB_2 were measured to temperatures above 1600°C by an x-ray method. Lattice constants were measured for each compound; each had the AlB_2-type hexagonal structure. The mean linear thermal expansion coefficients were calculated from the data and are compared with the values found in the literature. (auth)

18337 EFFECT OF PRESSING WITH A HIGH-PRESSURE APPARATUS ON WC–Co HARD METALS. Konno, Hiroshi (Mitsubishi Metal Mining Co. Ltd., Ohmiya, Japan); Kudaka, Katsuya; Matoba, Toshio; Ando, Masahisa. Nippon Kinzoku Gakkaishi, 30: 1063-8(1966). (In Japanese).

Using a modified girdle-type ultrahigh-pressure apparatus, WC–Co alloys containing 1.5 and 6 wt % in cobalt were loaded up to 20 to 70 kbars at room temperature and 1000° to 1800°C. From measurement of the microhardness, electron-microscopic observation and x-ray diffraction, the following results were obtained. Generally, with increasing pressure, the hardness increased above a certain pressure and reaches a maximum value, and then decreased rapidly. The increase in hardness was mainly due to the hardening of WC crystals or the microstress induced in WC crys-

tals and the decrease in hardness were due to local formation of microcracks by stress concentration in WC grains under high pressure. Stresses generated in the high pressure apparatus were divided into the environmental hydrostatic-pressure component and the compressive-stress component and the ratio of the two components depended on the coefficient of internal friction of the pressure medium. Generally, the hardness decreased by the annealing effect with increasing compression temperature. However, in the case of the hard metals whose hardness decreased as a whole by local fracture at room temperature, the hardness increased in a certain range of temperature because of contributions of the binder to the fractured grains at high temperatures. (auth)

18338 DECOMPOSITION PRESSURE, CONGRUENT MELTING POINT, AND ELECTRIC RESISTIVITY OF CERIUM NITRIDE. O'Dell, Kenneth Dean. Columbia, Mo., Univ. of Missouri, 1965. 66p.

Thesis.

Samples of CeN were melted in nitrogen at pressures between 10^{-2} and 21 atmospheres. Congruent melting was observed at T = 2575 ± 20°C for nitrogen pressures exceeding 5 ± 1 atmospheres. With lower nitrogen pressures, decomposition of the compound occurred with a subsequent lowering of the observed melting point. For these lower pressures, the melting point was related to the applied (or decomposition) pressure by the equation $\log P_{atm}(N_2) = 18.5 - 5.1 \times 10^4/T$. The electrical resistivity of samples prepared from these melts was measured at 150 to 900°K. Additional resistivity measurements were made on nonmelted samples, but the results were not as reliable. The room-temperature resistivity of congruently melted (and hence approximately of stoichiometric composition) samples was 21 μΩ-cm, which may be compared with the value of 75 μΩ-cm for cerium metal at this temperature. These samples of CeN had a positive (metallic) temperature dependence of resistivity of 0.11 μΩ-cm/°C at room temperature. This temperature dependence increased with temperature to a value of 0.22 μΩ-cm/°C at a temperature of 700°K, and remained this value at higher temperatures. The noncongruently melted samples had a similar behavior, but with somewhat higher values of resistivity. The room temperature Seebeck coefficients for both types of samples were approximately +5 μV/°C, relative to platinum. (Dissertation Abstr.)

Structure and Phase Studies

Refer also to abstracts 18285 and 18289.

18339 (ARL-66-0230) A STUDY OF THE ZIRCONIA-SCANDIA SYSTEM. Final Technical Report, October 1, 1965-September 30, 1966. Domagala, R. F. (IIT Research Inst., Chicago, Ill.). Nov. 1966. Contract AF 33(615)-3280. 18p. CFSTI $3.00 cy, $0.65 mn.

A tentative diagram for phase relations in the $ZrO_2-Sc_2O_3$ system is presented, based principally on metallographic analysis of as-cast and annealed specimens of ingots prepared by arc melting together calculated amounts of ZrO_2 and Sc_2O_3. A melting point vs composition study and a somewhat cursory x-ray investigation were conducted. Briefly, the ZrO_2-rich region of the system has been left open, since further study is required to define relations in this portion of the diagram. Two intermediate phases, one at ~25 wt % (~23.0 mole %) Sc_2O_3 (designated γ) and one at 32 wt % (29.6 mole %) to 42 wt % (39.3 mole %) Sc_2O_3 (designated δ), have been positioned. A eutectic L → δ + Sc_2O_3 solid solution has been placed at ~55 wt % (52.2 mole %) Sc_2O_3 and 2450°C. There is a broad solubility of Sc_2O_3 for ZrO_2; a single-phase field exists from 77 wt % (74.0 mole %) Sc_2O_3 to 100% Sc_2O_3. (auth)

18340 (LA-DC-8451) HIGH-TEMPERATURE NEUTRON DIFFRACTION STUDY OF LaC_2 AND YC_2. Bowman, A. L.; Krikorian, N. H.; Arnold, G. P.; Wallace, T. C.; Nereson, N. G. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 7p. (CONF-670502-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Presentation at 6th Rare Earth Research Conference, Gatlinburg, Tenn.

Examination of LaC_2 and YC_2 by high-temperature neutron- and x-ray-diffraction and by thermal analysis is reported. A tetragonal to cubic transformation has been observed at 1060°C for LaC_2 and at 1320°C for YC_2. The lattice parameters of LaC_2 are a = 4.00, c = 6.58A at 900°C and a = 6.02A at 1150°C. The parameters of YC_2 are a = 3.74, c = 6.20A at 1100° and a = 5.66A at 1400°C. The structure of the tetragonal phases was found to be of the C11a CaC_2-type, in agreement with previous room temperature results. The structure of the cubic phases is of the B1 NaCl-type with C_2 groups, similar to the structure of KCN. Both phases are isomorphous with the corresponding UC_2 phases. (auth)

18341 (UCRL-14465) ON THE EXISTENCE OF YTTRIUM ZIRCONATE. Smith, D. K. (California Univ., Livermore. Lawrence Radiation Lab.). Oct. 14, 1965. Contract W-7405-eng-48. 9p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The x-ray evidence of Fu'Kang, Kuznetsov, and Keler on the existence of $Y_2O_3 \cdot ZrO_2$ is discounted and neutron diffraction data given to refute their arguments for the existence of the compound. Evidence is presented for the nonexistence of a compound of the pyrochlore type at the composition $Y_2O_3 \cdot 2ZrO_2$. Instead there is a wide band of solid solution based on the CaF2-type structure at compositions on this portion of the phase diagram. (M.C.G.)

18342 NOTE ON THE CRYSTAL STRUCTURES OF $Nb_{11}O_{27}$, $Nb_{25}O_{62}$, AND H-Nb_2O_5. Norin, Rolf; Carlsson, Margareta; Elgquist, Bengt (Chalmers Inst. of Tech., Goteborg. Univ. of Goteborg. Univ. of Stockholm). Acta Chem. Scand., 20: 2892-3 (1966).

Continued investigations of the system NbO_x ($2.0 < x < 2.5$) are reported. Crystal studies were conducted on $Nb_{11}O_{27}$ and $Nb_{25}O_{62}$ as well as H-Nb_2O_5. Weissenberg photographs were taken using CuK radiation, and intensities were estimated visually. Calculations of structure factors, Fourier syntheses, and least-squares refinements were performed by SAAB D 21 computer. (P.C.S.)

18343 ROENTGENOGRAPHIC INVESTIGATION OF LANTHANUM BORIDES. Zhuravlev, N. N.; Manelis, R. M.; Gramm, N. V.; Stepanova, A. A. (Moscow State Univ.). Porosh. Met., Akad. Nauk Ukr. SSR, No. 2, 95-101(Feb. 1967). (In Russian).

On the basis of roentgenographic and metallographic investigations it was established that LaB_6 has a slight region of homogeneity, which evidently lies between the compositions of LaB_6 and $LaB_{6.5}$. The phase analysis of preparations with a boron content higher than in LaB_6 revealed a two-phase structure consisting of the basic phase of LaB_6 with a small deficit of La and free boron atoms. (auth)

18344 ORDERED PHYSIOSORPTION OF XENON ON GRAPHITE. Morrison, J.; Lander, J. J. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Surface Sci., 5: 163-5(Sept. 1966).

Electron diffraction patterns are shown that were obtained from a monolayer of Xe formed on a graphite single crystal surface cooled to about 90°K with ambient gas at about 1×10^{-3} torr. Features of the diffraction pattern showed that the Xe structure must have a unit mesh longer on edge by $\sqrt{3}$ and rotated by 30° with respect to the graphite substructure. It was noted that, at and near the monolayer concentration in the pressure and temperature range explored, the area occupied by Xe on the cleavage face of graphite is largely determined by the graphite structure. The close-packed plane of Xe atoms in solid Se (fcc) is less dense. It has an area per atom equal to 16.8 Å², whereas, according to the diffraction data, the area occupied on the graphite single crystal surface is 15.7 Å². Thus the atom appears to be laterally compressed by the substrate forces when the monolayer is brought into registry with the substrate configuration. Alternatively, adsorption may have caused the normal atom density of a single atom to be elongated normal to the surface and contracted parallel to the surface. If Kr and Ar behave in similar fashion, the 2D-crystal density is less than that of the close-packed bulk layer, and Ar (with an area per atom of about 12.8 Å² in the bulk) may increase in density during the 2D crystal → 2D liquid transition. (BBB)

18345 X-RAY STUDIES OF α-UMo_2O_8 AND α-$ThMo_2O_8$. Trunov, V. K.; Efremova, O. A.; Kovba, L. M. Radiokhimiya, 8: 717-18(1966). (In Russian).

It was previously shown that the β-$ThMo_2O_8$ system irreversibly converts to α-$ThMo_2O_8$ at 900°C (on the thermal curve β-$ThMo_2O_8$ the conversion corresponds to the effect at 950°C). The magnitudes of the interplane distances were found for the α-$ThMo_2O_8$ system. The thermal curve for UMo_2O_8 showed the endothermal effect at 1000°C. The x-ray picture of UMo_2O_8 annealed at 1000°C was identical to the x-ray picture of α-$ThMo_2O_8$. The x-ray pictures for α-UMo_2O_8 and α-$ThMo_2O_8$ were indexed. The isostructure of α-$ThMo_2O_8$ and α-UMo_2O_8 showed that in the UMo_2O_8 the uranium is tetravalent and molybdenum is hexavalent. (R.V.J.)

18346 PHASE STUDIES IN THE PSEUDOBINARY SYSTEM UN-UP. Baskin, Y. (Argonne National Lab., Ill.). J. Amer. Ceram. Soc., 50: 74-6(Feb. 21, 1967).

Samples were prepared at different compositions in the pseudobinary system UN-UP and were melted under atmospheres of helium, pressurized nitrogen, and helium-nitrogen mixtures. The tentative phase diagram showed no intermediate compound formation and only about 1% solubility of UN in the UP lattice. A eutectic occurred at about 2300°C and 40 wt % UP. (auth)

18347 ISOLATION OF THE ZETA PHASE IN THE SYSTEM TANTALUM-CARBON. Brizes, W. F.; Tobin, J. M. (Westinghouse Electric Corp., Pittsburgh). J. Amer. Ceram. Soc., 50: 115-16(Feb. 21, 1967).

Carbide layer-growth experiments confirmed that zeta is found

as a second phase in substoichiometric TaC. It is proposed that the zeta phase forms on cooling as a result of the decreasing solubility of carbon in the substoichiometric monocarbide with decreasing temperature. In addition to the precipitate zeta in the monocarbide, a separate layer of single-phase zeta was found in all TaC layer-growth experiments at isothermal-annealing temperatures from 1600 to 2200°C but not at higher temperatures. The stability of the zeta phase was indicated by this formation and by its persistence even after removal of compressive stresses by microdrilling. (P.C.S.)

18348 NATURE OF THE REACTION OF ZIRCONIUM DIOXIDE WITH TITANIUM, NIOBIUM, AND CHROMIUM CARBIDES. Kosolapova, T. Ya.; Fedorus, V. B.; Kuzma, Yu. B.; Kotlyar, E. E. (Inst. of Materials Science Problems, Academy of Sciences, Ukrainian SSR). Izv. Akad. Nauk SSSR, Neorg. Mater., 2: 1521-3(Aug. 1966). (In Russian).

The reaction of ZrO_2 with TiC, NbC, or Cr_3C_2 was studied at 1000 to 2000°C at 10^{-3} mm Hg by means of phase chemical and x-ray analyses. The reaction in the ZrO_2–TiC system begins at 1300°C, and at 1900 to 2000°C results in the formation of a phase identified as a complex oxycarbide of the approximate composition $(ZrO_{0.3}Ti_{0.7})(C_{0.56}O_{0.44})$ with lattice constant a = 4.43 Å. The reaction in the ZrO_2–NbC system begins at 1500°C. At about 1900 to 2000°C, a complex carbide of the type $(Nb_xZr_{1-x})C$ is formed in addition to a complex oxide of the type $(Nb_yZr_{1-y})O_2$. A chemical phase analysis based on the different solubilities of ZrC and NbC in mixtures of H_2O_2 and citric acid was elaborated. The reaction of ZrO_2 with Cr_3C_2 results at 1300°C in the reduction of ZrO_2 to ZrC and in the formation of the lower chromium carbide Cr_7C_3. It is concluded that the difference in the nature of the reaction of ZrO_2 with carbides of group IV, V, and VI metals is due to the difference in the electronic structure of the metal atoms forming the carbides. (ATD)

Radiation Effects

Refer also to abstracts 17564, 18301, and 18303.

18349 (COO–1255-4) RADIATION DAMAGE TO SILICA STRUCTURES. Technical Progress Report. Bale, Harold D. (North Dakota Univ., Grand Forks. Dept. of Physics). Feb. 28, 1967. Contract AT(11-1)-1255. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Data on x-ray scattering from unirradiated, pile irradiated, and quenched and annealed irradiated silica glass are reported. Scattering curves and radial distribution curves from glassy brown SiO and re-evaporated material are also shown. (P.G.C.)

18350 (EURAEC–1802) STUDY OF FISSION GAS RELEASE FROM UO_2 SAMPLES IRRADIATED AT VARIOUS DOSES. Annual Report, November 1, 1965–October 31, 1966. Special Report No. 1. Baffigo, V.; Gerevini, T. (comps.) (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). Contract 043-65-TEEI(RD). 20p. (EUR-3343). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Studies were made on the effects of radiation dose on the D′ coefficient of Xe diffusion in UO_2, as measured in post-irradiation annealing experiments. The measurements were made on UO_2 pellets, irradiated up to doses within few MWd/t and approximately 8,000 MWd/t and on fused UO_2 samples of four different origins, irradiated up to doses within few MWd/t and approximately 2,000 MWd/t. Preliminary results confirmed the decrease of D′ values with increasing irradiation doses for UO_2 pellets. A wide spread of D′ values was observed for UO_2 powders. (P.C.H.)

18351 (GEAP–5100B) HIGH PERFORMANCE UO_2 PROGRAM: IRRADIATION OF 0.5 INCH DIAMETER, SOLID PELLET UO_2 FUEL RODS AT 900,000 BTU/H-FT^2 PEAK HEAT FLUX. Lyons, M. F.; Nelson, R. C.; Pashos, T. J.; Wilson, C. R.; Weidenbaum, B. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Oct. 1965. Contract AT(04-3)-189. 203p. (EURAEC–1532). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The fabrication data, irradiation history, and complete, correlated post-irradiation examination results are described for a four-rod fuel assembly—designated EPT-8—that operated in the General Electric Test Reactor-Pressurized Water Loop (GETR-PWL) with significant central melting to a burnup of 1500 MWd/Te. The fuel rods were unsegmented, reactor-length rods containing 95 percent dense, solid, sintered UO_2 pellets in free-standing Zircaloy-2 cladding. This fuel assembly was the second of a series irradiated to investigate the feasibility and limitations in UO_2 fuel-rod operation with central melting. Post-irradiation examination of this assembly confirmed the clad swelling observations derived from the first assembly—EPT-6—and indicated that the swelling, expressed as a volume increase, is a function of the thermal performance level. This severe, localized clad swelling proved to be the basic obstacle to achieving satisfactory operation with central melting in high density fuel. Later work proved that the clad swelling resulted from the UO_2 phase change volume expansion and could be corrected by proper fuel rod design. (auth)

18352 (NP–16561) ETUDE EXPERIMENTALE DE CORROSION PAR LE GAZ CARBONIQUE ET DE PROTECTION DU GRAPHITE INDUSTRIEL NUCLEAIRE SOUS RADIATION. (Experimental Study of Corrosion by Carbon Dioxide and Protection of Nuclear-Grade Graphite Against Radiation). Arragon, P.; Seguin, M.; Tanis, G. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar. 1965. 40p. (In French). Dep. mn.

The radiolytic corrosion of graphite by CO_2 was measured by weight loss in samples irradiated in the presence of this gas. The results were compared with those predicted by a semiempirical formula. This formula was found valid at 350°C and 41 bars. The constant G_{-C} found in this formula was redetermined as 1.25. The precision limit of this measurement is discussed and estimated to be ±18%. Methane used in low concentration in CO_2 reduces the weight losses. (tr-auth)

18353 (NP–16565) REMARQUES SUR L'IRRADIATION EN COURS DE LA CAPSULE DE GRAPHITE NO. 3 A BR. 2. (Remarks on Irradiation of Graphite Capsule No. 3 in BR 2). Gentil, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Sept. 22, 1965. 41p. (In French). Dep. mn.

The graphite irradiation capsule No. 3 was introduced into the BR2 Reactor in April 1965. It remained in the reactor for four cycles. At the end of the third cycle important modifications were made to the core. The results showed that during each of the first three irradiation cycles there was a significant evolution of the nuclear heating flux with removal of the control rod. The results obtained are shown graphically. The effects of the new configuration on the irradiation capsule are not yet defined. (J.S.R.)

18354 (ORNL-TM–1653) IRRADIATION OF FUELED GRAPHITE FOR ADVANCED HIGH-TEMPERATURE GAS-COOLED REACTORS. Conlin, J. A.; Cunningham, C. W. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 60p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A series of six capsule-irradiation tests was made on cylindrical matrix-type fuel elements containing uncoated UC_2 particles or pyrolytic-carbon-coated UC_2 or $(U\text{-}Th)C_2$ particles. Those that contained uncoated fuel were encapsulated in low-permeability graphite as a barrier to fission-gas release. Fuel temperatures ranged from 2000 to 3500°F; power densities ranged from 10 to 300 W/cc; and burnups were up to 21 at. % ^{235}U. One capsule contained loose pyrolytic-carbon-coated fuel particles in sealed tubes, in addition to a matrix element. Fission-gas release was determined during irradiation by sampling the helium purge gas for analysis by gamma-ray spectrometry. Information on the overall stability of the fuels was determined by postirradiation examination. Information is also included on the design of the experimental equipment, operation, techniques, and fission-gas release. (auth)

18355 (SC-RR–66-2664) RADIATION EVALUATION OF A SMALL SAMPLE OF FN288 AND SU2105 JUNCTION FIELD EFFECT DEVICES. Phillips, A. R.; Sullivan, W. H. (Sandia Corp., Albuquerque, N. Mex.). Dec. 1966. Contract AT(29-1)-789. 73p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The neutron-induced changes in the electrical properties of four SU2105 and three FN288 field effect devices are described. Data are presented which define the behavior of eight selected electrical parameters at three flux levels ranging from 1.0×10^{13} to 9.5×10^{13} nvt, E > 0.01 MeV. In addition, graphs of the drain-to-source V-I characteristics of each device are presented for all flux levels. (auth)

18356 EFFECTS OF NUCLEAR RADIATION ON THE STRUCTURE AND ELECTRICAL PROPERTIES OF GRAPHITE. Popovic, Stanko (Ruder Boskovic Inst., Zagreb). Nukl. Energ., 3: No. 5, 19-24(1966). (In Slovak).

A study of the changes in the properties of domestic reactor graphite under the influence of neutron irradiation is presented. The effects of the interaction of neutron radiation with graphite are discussed, and models of radiation damage are presented. The effects of radiation on the structural characteristics of graphite and changes in the position, profile, and integral intensity of roentgen diffraction lines are discussed, and conclusions are drawn on the changes in the size of elementary particles, dis-

tortion of the crystal lattice, and on the nature of the defects induced. Description is given of measurements of variations in electrical resistance and in the Hall coefficient with a neutron dose, and of studies of radiation damage by the paramagnetic resonance method. A description of the effects of thermal treatment of irradiated samples on the recovery of defects, which is of particular significance for the application of graphite in reactor engineering, is given. (auth)

18357 NEUTRON-INDUCED DISPLACEMENT NUMBER IN SILICON. **Drain, D.; Pigneret, J.; Samueli, J.-J.; Sarazin, A. (Institut de Physique Nucleaire, Lyon). Solid-State Electron., 9: 1081-7(Nov.-Dec. 1966).**

Results are presented of experiments in which silicon transistors were used to determine relative changes of the neutron-induced displacement number in Si at various energy levels. (P.G.C.)

Plastics and Other Materials

Refer also to abstracts 18303, 18333, and 18779.

18358 (AECL-2532) WEAR OF PLASTICS IN ROOM TEMPERATURE WATER. **Dunn, J. T. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Feb. 1966. 36p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $1.00.**

The wear resistance of 22 self-lubricating plastics was determined in 80 to 160°F high purity water as $\frac{3}{4}$ in. sleeve bearings against type 304 stainless steel journals. Carbon filled TFE (tetrafluoroethylene) and high density polyethylene had the highest wear resistance over the range of loads and speeds used (18–108 lb/in.^{2} and 8–55 ft/min). In all cases the wear on the stainless steel journals was negligible compared to the wear on the plastic. In 80% of the tests the wear rates decreased with increasing sliding distance. This appeared to be the result of the gradual increase of hydrodynamic lubrication in the bearing wear scar aided by lubrication from transferred films. Filled TFE materials improved in wear resistance after gamma irradiation under water to 1.5×10^5 R while nylon, phenolic, epoxy, and Vespel showed a decrease after an exposure of 6×10^7 R. (auth)

18359 (N-66-29753) DEVELOPMENT OF A PROTOTYPE PLASTIC SPACE ERECTABLE SATELLITE. Quarterly Report, March–May 1966. **D'Agostino, Vincent; Keusch, Preston; Raffo, John (RAI Research Corp., Long Island City, N. Y.). June 27, 1966. Contract NAS5-3923. 67p. (NASA-CR-76045; RAI-368). CFSTI $3.00 cy, $0.65 mn.**

High density and standard density polyethylene films were tested to determine their tensile properties, and the data are tabulated. The standard polyethylene film was found acceptable, and samples were irradiated and heat treated under different ambient conditions to evaluate the effect of atmosphere on the processed film. Results indicate little influence on the mechanical properties. Calculations were also made to determine the thickness of film required to withstand a buckling pressure of five times solar pressure. Findings show a thickness requirement in the 0.50 to 1.48 mils range. (STAR)

18360 (Y-1574) ISOSTATIC PRESSING BAG MATERIALS. **Williams, J. L. (comp.) (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 10, 1967. Contract W-7405-eng-26. 50p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.**

Properties required of gum rubber and polyvinyl plastisol bags used in isostatic pressing of powdered materials are detailed. Techniques used in fabrication of bags are given as are specifications for materials and equipment used. (P.G.C.)

18361 PHYSICAL PROPERTIES OF TWO O-RING COMPOUNDS AFTER EXPOSURE TO REACTOR RADIATION. **Lewis, J. H. (General Dynamics Corp., Fort Worth, Tex.). Rubber Chem. Technol., 39: 1258-67(Sept. 1966).**

O-ring compounds, developed for improved radiation resistance, were studied for changes in physical properties as a function of reactor-radiation exposure level. The elastomers irradiated were an acrylonitrile-butadiene (NBR), resistant to air, water, fuels, and oils for use at –40 to 275°F, and a styrene-butadiene (SBR), resistant to air and water for use at –65 to 250°F. Six γ dose levels in the range from 4.9×10^8 to 1.5×10^{11} erg/g were used. O-rings and compression-set buttons of both materials were irradiated in air at near room temperature; O-rings of NBR were also irradiated in oil. Tensile properties, hardness, and compression set were measured as a function of radiation dose. Molecular weight between crosslinks and network-chain ratio as a function of dose were computed. The highest dose resulted in complete loss of useful mechanical properties. Properties most adversely affected at lower doses were ultimate elongation, hardness, and compression set. While compression set was 50% at a dose of 3×10^9 erg/g, tensile properties of both materials remained relatively good at a dose of 1.2×10^{10} erg/g. It is concluded that both materials have good radiation resistance and can be recommended for applications where resistance to degradation from nuclear radiation is required. (BBB)

18362 RADIATION EFFECTS ON PAINTS: EFFECTIVE COATINGS VITAL TO NUCLEAR INDUSTRY. **Watson, C. D.; West, G. A. (Oak Ridge National Lab., Tenn.). Mater. Protect., 6: 44-9(Feb. 1967).**

Effects of radiation on paints and future coating needs are discussed. Typical conditions to which paints are exposed, categorized according to severity and location (work areas) in the nuclear field, are outlined. Strippable coats can also be used. Protective paints are inexpensive, effective barriers to radionuclides and are among the easiest field applied surfaces to decontaminate. Epoxy, modified phenolic, and vinyl paints are the most widely used. Epoxy coatings reinforced with glass fabric seem quite promising for use in water-filled canals and in areas of high radiation and abrasion. Paints are needed in the nuclear industry that are extremely radiation resistant and easily cleaned. (BBB)

PHYSICS (GENERAL)

Astrophysics

Refer also to abstracts 18419, 18471, 18513, 18695, 18731, 18774, 18844, 18845, and 18851.

18363 (AD-647305) SOLAR MAGNETIC FIELDS. Final Report, November 29, 1965-November 28, 1966. Smith, Sara F. (Lockheed-California Co., Burbank). Dec. 1966. Contract N00014-66-C0058. 45p. (LR-20445).

Optical and magnetic field records of high resolution were obtained on 6 July 1965. These observations reveal an excellent correlation between the size, shape, and intensity of the H-alpha fine structures and the longitudinal component of the photospheric magnetic fields, except in the vicinity of the neutral line. Sections of the neutral line are marked by long fibrils running perpendicular to the neutral line or by small filaments paralleling the neutral line. The development of a major flare in this region appeared to be more precisely related to the neutral line than was found for the flares and magnetic fields observed with lower resolution. The 2 major segments of this flare lengthened in directions approximately parallel to the neutral line while simultaneously drifting perpendicularly away from the neutral line. The rate of drift systematically varied from 1 to 12 km/sec with increasing distance from strong fields. The rate of drift was also observed to decelerate throughout the life of the flare. A comparison of the distribution of various classes of magnetic regions shows that reversed polarity regions are relatively rare and tend to cluster around the solar equator. Complex bipolar regions occur most frequently at those latitudes where the density of all regions is highest. The ratio of complex bipolar to simple bipolar regions for the period studied was approximately 1:9. However, the complex bipolar regions were at least 3 times as flare-productive as the simple bipolar regions. Flare-productive complex magnetic field configurations may result when new regions form in older regions or when 2 or more regions appear to interact as a consequence of unusually close spacing. (auth)

18364 (N-67-13127) NON-LINEAR WAVES IN PLASMAS AND DISK-LIKE GALAXIES. Carmi, Gideon (Yeshiva Univ., New York, Belfer Graduate School of Science). June 1966. Contract AF 19(628)-4381. 42p. (NASA-CR-80486). CFSTI $3.00 cy, $0.65 mn.

Consideration is given to a simple model for a disk-like galaxy, the counterpart to a nonlinear cold plasma, to show that the analogy between cooperative waves in plasmas and in systems involving gravitational interaction extends beyond the domain of linear approximations. The method proposed is useful only as far as it can be carried exactly and merely to indicate the possible approximation procedures that may be taken to continue the solution. Exact solutions can be obtained in the Eulerian representation, whereas other treatments use the Lagrangian representation in varying degrees. (STAR)

18365 (N-67-13210) STATISTICAL EVALUATION OF PROTON RADIATION FROM SOLAR FLARES. Final Technical Report. Weddell, J. B.; Haffner, J. W. (North American Aviation, Inc., Downey, Calif. Space and Information Systems Div.). July 29, 1966. Contracts NAS7-100; JPL-951293. 176p. (NASA-CR-80531; SID-66-421). CFSTI $3.00 cy, $0.65 mn.

The occurrence probability of solar high-energy proton radiation was evaluated statistically as a function of radiation flux, solar activity level, and solar distance. The results are applicable to determining the solar proton radiation environment of spacecraft in interplanetary space between 1 and 2 astronomical units (AU) in the 1969 to 1975 time period. To estimate the probability distribution of expected radiation levels, the sunspot number in these years was predicted by extrapolating the Fourier transformation of the sunspot numbers from 1748 to 1964. Theoretical analyses were used to evaluate the temporal variation of the solar proton flux versus energy as a function of solar distance, and the correlation coefficient of the annual proton flux versus energy with the sunspot numbers from 1956 to 1963 was calculated. A specific Mars mission was considered to illustrate the techniques used in the study, and recommendations of additional study areas are also presented. (STAR)

18366 (NASA-SP-136) SIGNIFICANT ACHIEVEMENTS IN SPACE SCIENCE, 1965. (National Aeronautics and Space Administration, Washington, D. C. Scientific and Technical Information Div.). 1967. 227p. GPO $1.00.

The major areas of progress in the scientific and technical disciplines involved in space science and applications during 1965 are outlined. The following areas are included: space astronomy, ionospheres and radio physics, particles and fields, planetary atmospheres, planetology, and solar physics. (J.H.M.)

18367 (UCRL-50001-66-1, pp 54-66) HYDRODYNAMICS. (Lawrence Radiation Lab., Univ. of California, Livermore).

Brief summaries of research are presented for the following: two-layer numerical weather prediction model, semi-diurnal pressure variation of the atmosphere, hydrodynamic and thermodynamic evolution of arbitrary planetary atmospheres, elliptical galaxies, dynamic yielding and polymorphism in NaCl, shock-induced phase transition pressures in stainless irons, and development of an explosive gun. (M.O.W.)

18368 POLARIZATION OF COSMIC OH 18-cm RADIATION. Bender, P. L. (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Phys. Rev. Lett., 18: 562-4(Apr. 3, 1967).

A calculation is presented which indicates that the mechanism suggested by Heer (Phys. Rev. Lett., 17: 774(1966)) is not applicable to the OH microwave emission problem. The reason is that the incident radiation is not monochromatic but is instead amplified spontaneous emission with a spectral width which is very large compared with the non-Doppler part of the linewidth for the amplifying medium. This leads to the terms responsible for the effect of Heer and Graft (Phys. Rev., 140: A1088(1965)) being small compared with the normal saturation terms. For the calculation it was assumed that the pumping rates for the two polarizations are essentially the same, as is the case for the appealing differential absorption pumping mechanism which was suggested recently by Litvak et al. (Phys. Rev. Lett., 17: 821 (1966)). (W.D.M.)

18369 ISOTROPY AND HOMOGENEITY OF THE UNIVERSE FROM MEASUREMENTS OF THE COSMIC MICROWAVE BACKGROUND. Partridge, R. B.; Wilkinson, David T. (Princeton Univ., N. J.). Phys. Rev. Lett., 18: 557-9(Apr. 3, 1967).

A Dicke radiometer (3.2-cm wavelength) was used to make daily scans near the celestial equator to look for possible anisotropy in the cosmic blackbody radiation. After about one year of intermittent operation no 24-hr asymmetry with an amplitude greater than ±0.1% (of 3°K) was found. There is, however, a possibly significant 12-hr anisotropy with an amplitude of about 0.2%. (auth)

18370 TRITIUM LOSS IN IRON METEORITES. Schultz, L. (Max-Planck-Institut fuer Chemie, Mainz). Earth Planet. Sci. Lett., 2: 87-9(Mar. 1967).

The concentrations of cosmic-ray-produced ^{3}He in the medium octahedrites Ruff's Mountain and Roebourne are too low as compared to the concentrations of other spallogenic nuclear species. A number of arguments are compiled which indicate that the ^{3}He anomaly in these octahedrites and in some hexahedrites, as well as the low spallogenic tritium content in freshly fallen iron meteorites, is caused by diffusion loss of tritium due to solar heating of the meteorites in space. (auth)

18371 BINDING ENERGY OF NEUTRON STAR MATTER. Nemeth, J. (Cornell Univ., Ithaca, N. Y.); Sprung, D. W. L.; Bhargava, P. C. Phys. Lett., 24B: 137-9(Feb. 6, 1967).

The nuclear binding energy of neutron-star matter is calculated using the Reid potential and the Brueckner-Bethe many-body theory. The fractional density of protons in the system is found to depend strongly on the density dependence of the G matrix. (auth)

18372 DELTA-CEPHEI STARS FROM THE STANDPOINT OF STELLAR EVOLUTION. Hofmeister, Emmi (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Astrophys., 65: 194-225(Feb. 13, 1967). (In German).

A recent paper (Hofmeister, 1967) gave new evolutionary tracks for stars with five and nine solar masses. The calculations were done for a mixture with 4.4% heavy elements corresponding to extreme population I and a mixture with 2.1% heavy elements corresponding to median population I. These evolutionary tracks, which lead through the instability strip in the H-R diagram, make it possible to derive theoretical results for Cepheids: (a) the position of the instability strip in the H-R diagram; (b) the count of Cepheids in the interval $-2^m \leq M_v \leq -1^m7$; (c) the period-luminosity relation; (d) the frequency function; (e) period changes as a function of the period. The theoretical results are compared with observational data. Good agreement is found for the evolutionary tracks with long loops in the H-R diagram, and therefore many crossings of the instability strip. From the evolutionary tracks with only very short loops the observational properties of Cepheids cannot be explained. (auth)

18373 SEQUENCES OF INHOMOGENEOUS MODELS FOR HELIUM-BURNING STARS. Giannone, P. (Osservatorio Astronomico, Rome). Z. Astrophys., 65: 226-35(Feb. 13, 1967).

A two-parametrical set of inhomogeneous equilibrium models has been computed for stars at the beginning of their central helium burning. One parameter is the star's mass M; the other parameter is the fraction of the total mass, $q_0 = M_{He}/M$, where the composition changes discontinuously from the inner helium core to the outer hydrogen-rich envelope. The lines of constant q_0 start at the helium-star main sequence ($q_0 = 1$) and they are shifted over a wide range in the H–R diagram as q_0 is decreased down to 0.6. The variation of the mass–luminosity relation and of characteristic quantities for the structure of the helium core with changing q_0 are discussed. (auth)

18374 EVOLUTION IN A DOUBLE-STAR SYSTEM. I. MASS EXCHANGE BEFORE AND AFTER TERMINATION OF CENTRAL HYDROGEN BURNING. Kippenhahn, Rudolf; Weigert, Alfred (Univ.-Sternwarte, Goettingen, Ger. Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Astrophys., 65: 251-73(Feb. 13, 1967). (In German).

Computations for the evolution of a close binary-star component of 9 solar masses were carried out for two cases. Case A: After 1.2×10^7 years of hydrogen burning the volume of the star is equal to the volume enclosed by its Roche surface. Instead of following the evolutionary track for a single star, the star looses mass to its companion in a very short time of about 6×10^4 years. At the end of this rapid phase of mass loss, the mass of the star is 3.73 solar masses and the secondary has become the primary component. Then a slow phase of central hydrogen burning follows of about the same duration as the main-sequence phase. Mass loss continues but is very slow (mass exchange 4×10^{-8} solar masses per year). The stars form a semi-detached system with the secondary filling its Roche lobe. Case B: The critical volume is reached after the exhaustion of central hydrogen burning. At the end of the mass loss the mass is 2.016 solar masses. But the stars do not form a semi-detached system. The star which is now secondary contracts and settles down near the main sequence for helium-burning stars. Indeed, the star has lost its hydrogen envelope almost completely and is almost a helium star. (auth)

18375 GENERATION OF OSCILLATIONS IN THE SOLAR ATMOSPHERE IN SINGLE GRANULE. Meyer, F.; Schmidt, H. U. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Astrophys., 65: 274-98(Feb. 13, 1967). (In German).

The oscillations that originate from a granule rising and falling back at the lower boundary of an isothermal atmosphere overlaid by a hot corona were investigated. The motions are treated as isothermal. Solutions are obtained as a superposition of oscillations enforced by the lower boundary with free oscillations to insure initial rest. Three types of proper modes are excited: I. Sound waves modified by gravity. II. Pure horizontal sound waves. III. Incompressible gravity waves. Solutions are computed and energy spectra are derived for 6 cases. Case 1 corresponds to an 800-km granule of 8-min lifetime in a 7200°K atmosphere of 6 scale heights. The resulting oscillations agree in amplitude, period, and phase behavior with observations on the sun. In cases 2 to 6 the granular lifetime and size and the atmospheric height are varied. Solutions display the observed height decrease of the ratio of horizontal-to-vertical velocities and the growth of size of the elements with height. Whether gravity waves could cause the high-frequency tail observed in velocity spectra of chromospheric lines is considered. Agreement is found in shape of frequency spectrum, strength of excitation, growth rate with height, and phase and coherence relation between different lines. It is concluded that individual granules of the sun cause the observed oscillations. A 5-min 16-mm film was produced showing the motions of 50 grid points in a vertical cross section through the atmosphere for all 6 solutions. It is available at cost. (auth)

18376 OVERLAPPING METASTABLE LEVELS IN DIELECTRONIC RECOMBINATION. Trefftz, Eleonore (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Astrophys., 65: 299-310(Feb. 13, 1967).

Dielectronic recombination is important in hot dilute plasmas, for example, the solar corona. Burgess calculates this effect with the help of a semiclassical formula. Quantum mechanically this is correct as long as the possible metastable levels for a given transition are well separated energetically. Here the extension to overlapping levels is given. This involves a matrix inversion. For low densities and simple ions as found in the solar corona the order of the matrix is small ($< 6 \times 6$), so that the procedure seems feasible from a practical point of view. The formalism for the interaction between a number of metastable levels and autoionized states is described. This is generalized to the case of radiative decay. The connection to Burgess formula is given, and the solution of the general case is developed. Application of the theory to simple cases is described. (auth)

18377 SHELL STAR STUDIES. I. THE MAGNETIC RELEASE OF A CIRCUMSTELLAR RING. Hazlehurst, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Astrophys., 65: 311-26(Feb. 13, 1967).

A weakly magnetic star on the verge of rotational stability is assumed to have ejected a thin ring of gas. The motion of this ring is studied by means of a simple hydromagnetic model, and it is found that the gases describe a decelerated motion, compatible with the observed spectroscopic properties of circumstellar shells. The magnitude of the outward velocity depends on a number representing the ratio of the initial rotational energy to the initial magnetic energy of the ring. (auth)

18378 OBSERVATIONS OF HORIZONTAL MOTIONS IN SOLAR GRANULATION: THEIR RELATION TO SUPERGRANULATION. Simon, George W. (Sacramento Peak Observatory, Sunspot, N. Mex. Max-Planck-Institut fuer Astrophysik, Munich). Z. Astrophys., 65: 345-63(Feb. 13, 1967).

A quiet region of the sun was photographed simultaneously in Hα ($\Delta\lambda = +0.6$ Å) and in white light ($\lambda \approx 6400$ Å) every five seconds for 1500 seconds under excellent seeing conditions on May 21, 1965 at Sacramento Peak Observatory. In the nineteen best-quality frames chosen for analysis, a total of 43,914 measurements were made of granule coordinates and velocities, these being then correlated with the granules, positions inside supergranules, as defined by the Hα network. Statistical analysis of the data indicate that the granules tend to move toward the network boundaries, apparently drifting in the direction of the supergranule flow pattern. The lifetime of solar granulation was also obtained during the data reduction and found to be eight minutes. (auth)

18379 ON THE CENTER-LIMB VARIATION OF THE H- AND K-LINES OF Ca II. Engvold, Oddbjoern. Astrophys. Norv., 10: 101-25(Sept. 1966).

It is assumed that the K_2 emitting regions, responsible for the mottles, on the average extend to a height $h = h^* \sim 3000$ km. These emission elements are surrounded by a "cool" gas causing the K_3 absorption. This absorption takes place mainly for heights $h \geq h^*$. The optical depth in the K_3 absorbing gas at the geometric height $h = h^*$ will increase with heliocentric distance, θ. This gives rise to stronger absorption of the K_2 emission with increasing θ, and therefore an increased separation of the emission peaks as the limb is approached. This effect combined with an increase in the width of the K_2 emission line, produces the observed center-limb variation. Based on this hypothesis the center-limb variation of $\Delta\lambda_2$ (half the separation between the K_2 emission peaks) is calculated. The optical depth in the K_3 absorbing layer is estimated from the mean observed H- and K-line profiles of Goldberg et al. (1959). Assuming six different models for the variation of Ca II ion density with height, and six values of the microturbulent velocity in the K_3 component, the center-limb variation of $\Delta\lambda_2$ is evaluated. Within the range of density covered by the six models the center-limb variation is shown to depend only upon the turbulent velocity in the chromosphere. A turbulent velocity $\xi_t = (7.5 \pm 0.5)$ km/sec is consistent with the observations of $\Delta\lambda_2$ at the Oslo Solar Observatory. This value of the turbulent velocity in heights $h \geq 3000$ km is in fair agreement with previous results. Evidence is presented for the view that the K_2 regions are optically thin. The asymmetry of the doubly reversed profiles requires an upward directed velocity of ~1.0 km/sec for the K_2 regions, relative to the "cool" gas. There is strong evidence for a "cool" interspicular component extending up to $h \sim 5000$ km. (auth)

18380 CONTRACTION AND PULSATION OF VERY MASSIVE STARS. Unno, Wasaburo; Kato, Shoji; Osaki, Yoji (Tokyo Univ.). Z. Astrophys., 65: 327-44(Feb. 13, 1967).

Various physical conditions which characterize the transition from the free-fall stage to the Helmholtz–Kelvin contraction stage are discussed for very massive stars of 10^3 to 10^6 $M_\odot$. Then, the excitation of pulsation during the contraction stage is calculated. If the hydrodynamic "bounce" in the core stops the free fall, the first quasi-equilibrium configuration at the beginning of the Helmholtz–Kelvin contraction stage is formed with a central temperature and density of about $10^{8.5}$°K and $1.6 \cdot 10^{-7}(M/M_\odot)^{-}$ g cm^{-3}. The pulsation of very massive stars should be dominantly of the fundamental mode, irrespective of the initial disturbance The amplitude of pulsation relative to the stellar radius is increased proportional to R^{-3} by the thermodynamic interaction with the gravitational contraction. Thus, the relative amplitude grows by a factor of about 100 until the star reaches the hydrogen-burning stage ($T_c \sim 6 \cdot 10^{7}$°K, $\rho_c \sim 30(M/M_\odot)^{-2}$ g cm^{-3}), provided that energy loss due to the effects of large amplitude can be neglected. (auth)

18381 HYPOTHESIS OF QUASI-STELLAR RADIO SOURCES. Nedyalkov, I.; Kalinkov, M. (Astronomical Section, Sofia, Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 18: 509-12(1965).

The discovery of powerful star-like radio sources of the 3C273 and 3C48 type has given rise to various hypotheses trying to explain their character. In the final analysis, all the hypotheses may be classified as scintillation or nonscintillation. A new scintillation hypothesis is tentatively proposed, which gives the physical characteristics of the superstars after making certain assumptions. The model is based on the assumption that, if a body with sufficiently large mass is formed in the nucleus of a galaxy, an accretion of surrounding stars will occur. (W.D.M.)

18382 HOT MODEL OF THE UNIVERSE. Zel'dovich, Ya. B. Usp. Fiz. Nauk, 89: 647-68(Aug. 1966). (In Russian).

This review article describes the status of cosmology after the discovery of the presence of an isotropic radiation in the universe at wavelengths 7, 3, and 0.25 cm, corresponding to a temperature of approximately 3°K. The existence of such radiation, predicted on the basis of Friedmann's theory of the expanding universe, has provided an impetus for further development of the hypothesis of the hot model, in which it is assumed that, in the prestellar state, matter was characterized by a very large entropy. The evolution of such a universe from a temperature of 10^{10}°K at t = 1 sec to 3°K at the present time is traced, and the generation of various elementary particles during its various stages is discussed. The existence of a hot intergalactic plasma and possible sources for its heating is also discussed. The theoretical difficulties of the hot model, still remaining, are the question whether a quantum theory can be constructed for the transition from compression at $t < 0$ to expansion at $t > 0$, the nature of the initial specific entropy of matter in the hot model, the existence of superdense bodies under gravitational radius, vortical motion in magnetic fields, theory of formation and evolution of "ordinary objects" (stars, galaxies, clusters, quasars), and the very nature of the expansion of the universe (cyclic or one-time processes). The main conclusion of recent developments are that Friedmann's theory, in spite of not having been fruitful for the last 30 to 40 years, is still basic, and that the earth, the sun, and the galaxy do not move with large velocity relative to the radiation field. An appendix describes the latest experimental results on radiation measurements at short waves, the nature and mechanics of the hot model, the nature of the entropy, and role of nuclear reactions and gravitation in the hot model, as well as references to other published works. (ATD)

18383 POWERFUL X RADIATION FROM THE RADIO GALAXIES. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 89: 549-62(Aug. 1966). (In Russian).

This review article was stimulated by recent observation of powerful x-ray sources in A-Cygni. It deals with the history of x-ray astronomy since the observation of x radiation from the sun in 1948 and with the main results obtained in x-ray astronomy of the galaxy and of the metagalactic regions. The major sources of cosmic x radiation are listed and their luminosities given. The nature of the cosmic x radiation is discussed and the most important processes which can give rise to x rays are described (bremsstrahlung, characteristic radiation due to atomic transitions, synchrotron radiation, Compton radiation). Estimates of the relative contributions of the different mechanisms are given. Further prospects and the required apparatus are discussed. (ATD)

18384 PROBLEM OF QUASARS. Smith, F. G. (Univ. of Manchester, Eng. Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Nature, 213: 967-9(Mar. 11, 1967).

Quasars create more problems than they solve. How can such small star-like objects emit such large quantities of energy? Why do their spectra show such anomalously high red shifts? How are they related to radiosources and visible stars? These problems are discussed in some detail. (UK)

18385 VARIATIONS IN THE FLUX DENSITY OF SOME QUASI-STELLAR SOURCES. Kellermann, K. I.; Pauliny-Toth, I. I. K. (National Radio Astronomy Observatory, Green Bank, W. Va.). Nature, 213: 977-80(Mar. 11, 1967).

Further data on the variations in the 1.96-cm flux density of the quasars 3C 273, 3C 279, 3C 446, and 3C 454.3 are reported. The data support the theory that the variation is produced by repeated injection into a magnetic field of clouds of relativistic electrons, which then expand; but some difficulties remain to be explained. (UK)

18386 SEARCH FOR VERY HIGH FREQUENCY RADIATION RESULTING FROM THE PASSAGE OF COMET 1965f THROUGH THE SOLAR CORONA. Croom, D. L. (Radio and Space Research Station, Ditton Park, Eng.). Nature, 213: 1002-3 (Mar. 11, 1967).

It is stated that on Oct. 21, 1965, a rare solar event occurred, when the "sun-grazing" comet 1965f passed through the solar corona at a perihelion distance of less than 500,000 km from the sun's surface. The station's satellite telemetry reception equipment at Singapore, operating at 136 Mc, was used to monitor the solar radiation to ascertain whether or not the interaction of the comet with the region of the solar corona in which very-high-frequency radiation normally originates would produce any detectable increases. It was concluded that the interaction did not produce any significant enhancement of emission at 136 Mc. (UK)

18387 SEARCH FOR THE Λ-DOUBLET TRANSITION IN THE $^2\Pi_{\frac{1}{2}}$, J = ½ STATE OF OH. Zuckerman, B.; Palmer, P.; Penfield, H. (Harvard Coll. Observatory, Cambridge, Mass.). Nature, 213: 1217-18(Mar. 25, 1967).

Recent radioastronomical investigations of the 18-cm ground state Λ-doublet transition of the OH radical have suggested that maser amplification of the radiation is taking place in the interstellar medium. No entirely satisfactory theoretical explanation of the observations has been published. Suggestions put forward are reviewed. Studies using the 140-ft telescope of the National Radio Astronomy Observatory at Green Bank, West Virginia, are described. The equipment included a parametric amplifier and the Harvard University 21-channel spectral line radiometer. Observational results are tabulated (sources W3 and W49; transitions F = 1 → 1, 1 → 0, 0 → 1; line frequencies; frequency range covered; $\Delta T/T_{1665}$). Because of the unknown nature of the pumping mechanism in the ground state it appeared worth while to look for the line at 4717 Mc. The $^2\Pi_{\frac{1}{2}}$ lines were not detected in W3 and W49—two radio sources of known 10-cm OH emission. The studies placed upper limits on the intensities of the $^2\Pi_{\frac{1}{2}}$, J = ½ Λ-doublet lines—these are 1 to 2% of that of the observed 18-cm Λ-doublet emission lines. (UK)

18388 POSITION OF THE LOW-FREQUENCY RADIO SOURCE IN THE CRAB NEBULA. Gower, J. F. R. (Cambridge Univ., Eng.). Nature, 213: 1213-14(Mar. 25, 1967).

Recent radio observations of the Crab Nebula have demonstrated the existence of a component of small angular diameter which contributes a significant fraction of the total flux density at frequencies < about 100 Mc. The high brightness temperature deduced from the interplanetary scintillation of this souce at 38 Mc makes it difficult to attribute this radiation to the synchrotron process, and coherent radio emission from a dense plasma associated with the source has been suggested as a possible mechanism. The previously reported position for this small source, based on a lunar occultation observed at 26.5 Mc lies about 1.2′ arc from the center of the nebula and is well removed from the center of the observed expansion. Present observations indicate that the position must be much nearer the center of the nebula. The method employed in these observations made use of the fact that only the small component of the nebula exhibits interplanetary scintillation. By observing the magnitude of (a) the total signal and (b) the scintillations on the record obtained with a phase-switching interferometer, it was possible to determine the phase difference of the two interference patterns, and thus the difference in position of the small source and the centroid of the brightness distribution of the nebula. The method avoids the need for corrections for ionospheric refraction. Measurements were made at 81.5 Mc using a Cambridge interferometer. The derived final position (0.3′ ± 1.0′ south of the centroid) agreed with that of the pair of 15 M⊙ stars near the center of the Crab Nebula. It has been suggested that this low-frequency radio source may be associated with the recently discovered x-ray source in the Crab Nebula. (UK)

18389 ANGULAR SIZE AND FLUX DENSITY OF THE SMALL SOURCE IN THE CRAB NEBULA AT 81.5 Mc/s. Bell, S. J.; Hewish, A. (Cambridge Univ., Eng.). Nature, 213: 1214-16(Mar. 25, 1967).

The existence of a source in the Crab Nebula with an angular diameter <1 sec arc has been revealed by observations of interplanetary scintillation at 38 Mc. The brightness temperature is so great that the synchrotron mechanism may not provide an adequate explanation for the emission. Determination of the spectrum was therefore of great interest. It has proved difficult in observations at other frequencies, based on lunar occultations and interferometers of high resolving power, to recognize the contribution from this very compact component in the presence of other fine structure within the nebula. Further observations of interplanetary scintillation at 81.5 Mc were therefore made, first to enable the flux density to be determined at this frequency and also to derive a more accurate value for the angular diameter of the source. Experimental techniques employed are described and results discussed. The derived angular diameter was 0.2″ ± 0.1″, a value somewhat greater than that derived from the earlier observations at 38 Mc, but the new value is believed to be more accurate since it is based on direct measurement of the scale of the diffraction pattern at the Earth. Until more is known about the diffraction pattern at 38 Mc there is no evidence that the angular

diameter depends on frequency. The estimated relative intensity of the small source is 10 ± 1.5%, the greatest uncertainty being due to day-to-day changes in the irregularities of the interplanetary medium. Calculations using the revised angular diameter lead to upper limits of 3×10^{-6}G and 2×10^{-7}G at 81.5 and 38 Mc, respectively, for the field strength in the source if radiation by the synchrotron mechanism is assumed. The corresponding minimum energies for relativistic electrons alone are then $\sim 10^{47}$ and $\sim 10^{50}$ ergs. It is therefore difficult to account for the compact source by synchrotron radiation since this requires both an unreasonably small magnetic field and a minimum particle energy of the same order as that contained in the complete extended source. (UK)

18390 POLARIZATION OF COSMIC X RAYS. Korchak, A. A. (Inst. of Terrestrial Magnetism, Moscow). Nature, 213: 1209-10(Mar. 25, 1967).

It is stated that the extent to which cosmic x rays are polarized may provide information concerning the mechanism by which they are produced, and their place of origin. Continuous cosmic x rays may be produced by three mechanisms—bremsstrahlung (thermal and non-thermal), synchrotron radiation, and the inverse Compton effect. Polarization for these three mechanisms has been investigated and the conclusion reached that the observation of high polarization means that the radiation is either synchrotron or bremsstrahlung radiation of electrons, the velocity vectors of which are non-isotropic. The latter possibility is considered, which is probably realized in solar flares and possibly in some other x-ray sources. (UK)

18391 X-RAY EMISSION LINE SPECTRUM OF A CORONAL ACTIVE REGION. Evans, K. (Univ. of Leicester, Eng.); Pounds, K. A.; Culhane, J. L. Nature, 214: 41-2(Apr. 1, 1967).

Solar x-ray emission below 25Å was measured using two slitless Bragg spectrometers on a sun-pointed Skylark rocket flight (SL 304) on May 5, 1966. Photons were detected with thin plastic window proportional counters. The launch took place during a period of relatively quiet solar activity. The apogee of the rocket was such as to give negligible atmospheric attenuation for the wavelengths measured. Scans were made over the wavelength band 11 and 25Å. The line identifications obtained are given, several of which had not previously been seen in the solar spectrum. Wavelengths were determined for the stronger lines. The 9.1-cm radio map for May 4th showed a weak belt of activity at solar latitude 20 to 30°N, dominated by a strong active region in the NW quadrant. The strong narrow peaks were attributed unambiguously to emission from the dominant active region. The observed "active region" emission lines are tabulated. New lines of iron XVII and new line series of neon IX and X, iron XVIII, and nickel XIX were observed. Energy fluxes for the lines are being reduced. The results should afford independent temperature and density measurements for the active emission region, and also yield abundance data. (UK)

18392 LINEAR POLARIZATION OF RADIO SOURCES AT A WAVELENGTH OF 21.3 cm. Branson, N. J. B. A. (Cambridge Univ., Eng.). Nature, 213: 1211-13(Mar. 25, 1967).

High-resolution observations of a number of radio sources were made using the Cambridge One Mile Radiotelescope. These sources included the Crab Nebula, Cygnus A, 3C 47, 103, 332, 338, and 4C 29.41. Maps of the sources at two perpendicular polarizations were compared, enabling information concerning the distribution of polarization across the sources to be obtained. (UK)

18393 IMPLICATIONS OF THE OBLATENESS OF THE SUN. Roxburgh, I. W. (Univ. of Sussex, Eng.). Nature, 213: 1077-8 (Mar. 18, 1967).

Recent measurements of the oblateness of the sun have been used to determine its quadrupole moment and also the effect on the perihelion of Mercury. The results are of importance both in connection with tests of the general theory of relativity and with theories of stellar rotation. The deductions made from a measure of the oblateness are examined and it is shown that the calculations could well be incorrect. The deductions assumed that the surface of the sun has a constant total potential (gravitational plus rotational), but arguments are advanced, based on temperature and pressure considerations, that the surface is not constant potential, and that the sun is rotating slowly throughout its mass, producing no detectable effect on the motion of Mercury. (UK)

18394 GALACTIC DISCONTINUITY AT $l^{II} = 140°$. Reddish, V. C. (Royal Observatory, Edinburgh). Nature, 213: 1107-8 (Mar. 18, 1967).

There is substantial evidence of a major discontinuity in the structure of the Galaxy at $l^{II} = 140°$. This evidence is provided by large changes in the numbers of Wolf–Rayet stars, dust-embedded stars and interstellar globules, by the wavelength dependence of the position angles of interstellar polarization of starlight, and by the orientation of the polarization vectors of galactic radio waves on each side of this longitude. Observations support the views that massive stars form from globules and that Wolf–Rayet stars are very young objects in the last stages of contraction to the main sequence. They also indicate that the region $l^{II} = 140°$ to 250° is not at present active in the formation of massive new stars. It was indicated that a survey of the distribution of globules in young clusters and associations would be useful; this survey is briefly described. Measurements of the wavelength dependence of the position angles of the interstellar polarization vectors of starlight show a systematic dependence on galactic longitude for about half the stars. Polarization of the galactic radio noise at 408 and 610 Mc is very strong at $l^{II} = 141°$, $b^{II} = +6°$, a region which appears to be the focal point of a pattern of symmetry in polarization. It is possible that a similar discontinuity in the reverse sense occurs at $l^{II} = 250°$. (UK)

18395 MEASUREMENTS OF OH EMISSION SOURCES WITH AN INTERFEROMETER OF HIGH RESOLUTION. Davies, R. D. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.); Rowson, B.; Booth, R. S.; Cooper, A. J.; Gent, H.; Adgie, R. L.; Crowther, J. H. Nature, 213: 1109-10(Mar. 18, 1967).

Previous experiments to determine the angular size of the OH emission regions, employing interferometers with baselines of about 0.5 km (~3000 wavelengths), showed no resolution of emission sources, indicating that angular sizes were <20 arc secs. Measurements are described employing a baseline of 127 km (7.0×10^5 wavelengths at 18 cm), representing an increase of 200 in resolving power. An Argus 100 computer was used. Observations were made of the features in the 1665 Mc spectra of the OH emission sources near W3, W24-B2, W49, and W75, and in the 1667 Mc spectrum of W49. Fringes were observed over a wide range of hour angles for the strong features in all the spectra investigated. Fringe amplitudes were converted into flux densities. Values are tabulated for diameters of components of the OH emission sources. For the nearer OH sources (W3 and W75) the linear diameters are less than about 6×10^{-4} parsec, and for the more distant sources (W24-B2 and W49) less than about 10^{-2} parsec. From the observations the picture emerges of compact OH sources near H II regions with overall dimensions of about 10^{-2} parsec. Within these sources narrow spectral components of characteristically high left-hand or right-hand circular polarization are emitted from smaller regions with apparent diameters $<10^{-3}$ parsec. Such a source configuration would be consistent with a maser amplification process for the OH emission. (UK)

18396 X-RAY ASTRONOMY EXPERIMENTS. Salpeter, Edwin E. (Cornell Univ., Ithaca, N. Y.). Comments Nucl. Particle Phys., 1: No. 1, 28-31(Jan. 1967).

A review is presented of some recent observational work in celestial x-ray astronomy, which has revealed about a dozen discrete x-ray sources outside the solar system so far, mainly in the energy region of 1 to 10 keV. The review also contains references to the earlier work by the NRL group, the Cambridge group, and the Lockheed group. (L.B.S.)

18397 EFFECT OF GRAVITATIONAL SCALAR FIELD ON HIGH-DENSITY STAR STRUCTURE. Salmona, A. (Goddard Inst. for Space Studies, New York). Phys. Rev., 154: 1218-23 (Feb. 25, 1967).

The theory of gravitation allowing variation of the gravitational constant G by means of a scalar field introduced by Brans and Dicke is applied in the case of a fluid sphere in gravitational equilibrium. The departure of the mass-radius relation in this theory from the Einstein theory is investigated for different values of the constant ω and for high central-energy densities in completely degenerate stars (neutron stars). (auth)

18398 SOLAR-WIND-INDUCED TORQUE ON THE SUN. Modisette, Jerry L. (Rice Univ., Houston, Tex.). J. Geophys. Res., 72: 1521-6(Mar. 1, 1967).

The torque on the sun is determined by the solution of the equations of motion of the solar wind, taking rotation and magnetic forces into consideration. Through the solutions it is shown that the torque is the same as that calculated by assuming rigid body rotation of the corona out to the radius, at which the solar wind velocity is equal to the Alfvén velocity, and flow with constant angular momentum thereafter. It is also shown that most of the torque is not the result of co-rotation, but it is primarily the product of electromagnetic radiation of angular momentum. The results are consistent with the torque derived by Brandt [1966] from comet tail deflections if one assumes that comet tails are deflected by the total momentum flux in the solar wind rather than by the particle momentum flux alone. (auth)

18399 STELLAR EVOLUTION: COMPARISON OF THEORY WITH OBSERVATION. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Science, 155: 785-96(Feb. 17, 1967).

An understanding of those nuclear-burning phases in which a star spends most of its active, luminous life is relatively secure. Puzzles still remain, and the theoretical structure is far from complete, but, on the whole, comparison between the observations and theoretical models of evolving stars engenders confidence. Topics discussed in some detail are evolution of a typical metal-rich star, hydrogen burning in the core, the giant branch, helium burning in the core, dependence of evolutionary characteristics on stellar mass, the main-sequence phase, post main-sequence phases, comparisons with the sun, Capella, and cluster stars, and problems posed by metal-poor stars. (W.D.M.)

18400 RED-SHIFTS AND POWER OUTPUTS OF QUASI-STELLAR RADIO SOURCES. Roeder, R. C.; Mitchell, G. F. (David Dunlap Observatory, Richmond Hill, Ont.). Nature, 212: 165-6(Oct. 8, 1966).

The opinion of Hoyle and Burbidge that the red shifts in the spectra of quasars are not related to distance is considered to be unduly pessimistic, and it is concluded that the quasars can be satisfactorily interpreted on a cosmological basis. This conclusion is based on the construction of a log z versus m_r diagram for known radio galaxies and the analysis of a somewhat similar diagram for the quasars which, given the cosmological interpretation, leads to results consistent with the log N−log S diagram. (W.D.M.)

18401 NEUTRINOS AND GRAVITONS IN THE ANISOTROPIC MODEL OF THE UNIVERSE. Doroshkevich, A. G.; Zel'dovich, Ya. B.; Novikov, I. D. (Steklov Inst. of Applied Mathematics, Academy of Sciences, USSR). JETP Lett. (USSR) (Engl. Transl.), 5: 96-8(Feb. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 119-21(Feb. 15, 1967).

Anisotropic cosmological solutions are discussed in connection with the chemical composition of prestellar matter and the primordial magnetic field. These solutions approach, asymptotically, Friedmann's isotropic solution and, in this respect, they do not contradict the observations. The picture of anisotropic expansion is radically altered when weakly interacting particles (neutrinos and gravitons) are taken into account in the composition of prestellar matter. (W.D.M.)

18402 WORLDS–ANTIWORLDS: ANTIMATTER IN COSMOLOGY. Alfven, Hannes. San Francisco, W. H. Freeman and Co., 1966. 109p. $3.50.

Translation by Rudy Feichtner of Vaerlden–Spegelvaerlden: Kosmologi och Antimateria.

A theory of the universe based on symmetry in the production of particles and antiparticles is presented which is aimed at the general audience. The necessary background is provided in brief sketches of the historical development of cosmology, of its present state, and of the recent developments in particle physics and plasma physics that have important bearings on cosmology. The theory is compared to other models. (W.D.M.)

18403 OBSERVATIONS OF THE RADIO FREQUENCY BRIGHTNESS DISTRIBUTIONS IN SEVERAL NORMAL SPIRAL GALAXIES. De Jong, Marvin Lee. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 110p.

Thesis.

Observations of the galaxies M 31, M 33, IC 342, NGC 3031, NGC 4258, NGC 4565, and NGC 5457 were made with the NRAO 300-foot telescope at frequencies of 750 and 1410 MHz. All of these galaxies are normal Sc- or Sb-type spirals. The rf brightness temperature distributions observed show that the sizes of the radio-emitting regions in these galaxies differ considerably. A new model of the radio halo is suggested. In this model the extent of the halo may vary from galaxy to galaxy. Only one galaxy, M 31, shows an extensive halo of the type suggested by Hanbury Brown and Hazard (1961) for all normal spiral galaxies. The present observations and the observations of Mathewson and Rome (1963) indicate that an extensive halo of the type around M 31 is rare. The radio luminosities of several of the galaxies investigated are of the order of 10^{38} ergs/sec and are independent of the size of the region in which the radio emission originates. On the basis of equipartition, the synchrotron theory predicts magnetic field intensities of about $4-10 \times 10^{-6}$ gauss in the central regions of the galaxies and about $1-3 \times 10^{-6}$ gauss in regions where the emissivity is about one percent of its central value. Various hypotheses concerning the origin of the halo and the sources of the relativistic electrons are examined. In view of the results for the brightness temperature distributions, an evolving model of the halo described by Burbidge and Hoyle (1963) is most attractive. It has been shown that the hypothesis and supernovae are the primary sources of relativistic electrons meeting with difficulties when systems such as NGC 4258 are considered. The possibility that normal spiral galaxies have a multiple radio structure was suggested by the contour maps. This possibility was examined and the evidence given here indicates that this is indeed the case. (Dissertation Abstr.)

Atomic and Molecular Physics

Refer also to abstracts 17830, 18364, 18604, 18617, 18751, 19027, 19056, and 19112.

18404 (AD-642525) RESEARCH ON METASTABLE SPECIES IN ATOMIC AND MOLECULAR BEAMS PRODUCED BY CHARGE TRANSFER. Semi-Annual Report. Lorents, D. C.; Peterson, J. R. (Stanford Research Inst., Menlo Park, Calif.). Oct. 31, 1966. Contract DA-31-124-ARO(D)-446. 19p. CFSTI $3.00 cy, $0.65 mn.

Near-resonance charge-exchange reactions are being used to convert beams of ions to beams of neutrals containing a large fraction of excited particles. The high cross sections of these charge-exchange reactions allow efficient conversion of ions to neutrals. Present studies are devoted to identification and detection of excited states of the neutrals in the beam. First results of this work are reported. One of the significant results is the realization of a direct and practical method of measuring radiation lifetimes of diatomic molecules. (auth)

18405 (AERE-M-1813) TWO POSSIBLE USES OF AN ELECTRON-OPTICAL STRUCTURE FOR PROCESSING OPTICAL SIGNALS MODULATED AT FREQUENCIES UP TO 10^{12} CYCLES/SEC. Iredale, P. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1967. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 1s. 9d.

A means is suggested for modulating an electron beam by sweeping it across a mask that is alternately opaque and transparent to electrons. The chopping frequency this produces can, in some circumstances, approach 10^{12} cycles/sec. The suggested device could be used to operate on the electron signal produced at a photocathode by a modulated light beam of small area. Hence, the signal and the chopping modulations could be mixed. The device would represent a frequency changer that could operate at frequencies up to 10^{12} cycles/sec. The same sweeping system is suggested as a means of performing a series-to-parallel conversion with a digitally coded optical signal as input and some 60 parallel electrical outputs. (auth)

18406 (N-67-10798) ONSET OF ANOMALOUS DIFFUSION IN ELECTRON-BOMBARDMENT ION THRUSTOR. Cohen, Allen J. (National Aeronautics and Space Administration, Cleveland, Ohio. Lewis Research Center). Nov. 1966. 26p. (NASA-TN-D-3731). CFSTI $3.00 cy, $0.65 mn.

Noise measurements and variations of ion production energy per beam ion with magnetic field indicate an onset of anomalous diffusion in the electron-bombardment ion thrustor. Application of stability theory of the Kadomtsev- and Nedospasov-type yielded an expression for the critical magnetic field for the onset of anomalous diffusion and an expression for the oscillatory frequency associated with the anomalous diffusion. The derived behavior of the critical magnetic field is similar to an experimentally derived scaling law for the ion thrustor. Calculated values of the critical magnetic field for mercury and argon propellants agreed well with those obtained from experimental values determined from curves of ion production energy per beam ion. Expressions for ion production energy per beam ion are given for both the classical and the anomalous regions. A theoretical value of the oscillatory frequency was calculated to be in the same frequency regime as an experimental value of a device dominated by a similar type of anomalous diffusion. (auth)

18407 (N-67-13184) INVESTIGATION OF KILOVOLT ION SPUTTERING. Quarterly Progress Report, August-October 1966. Smith, Harold P. Jr.; Hurlbut, F. C.; Pigford, T. H.; Khan, Jhan; Olson, N. Thomas (California Univ., Berkeley. Space Sciences Lab.). Oct. 31, 1966. Contract NAS3-5743. 20p. (NASA-CR-72012). CFSTI $3.00 cy, $0.65 mn.

This work constitutes an area of surface physics involving the interaction of ions and protons with material surfaces. Specifically, heavy ion (cesium and mercury) surface interactions are observed by measuring sputtering yields, angular distribution of sputtered atoms, energy distribution of ejected atoms and implanted ion distributions within the target lattice. The proton-surface interaction studies constitute an investigation of the proton induced characteristic oxygen x rays as a possible surface analysis device for measuring oxygen contamination of material surfaces. (auth)

18408 (NYO-1480-68) CORRELATIONS AMONG ATOMIC ELECTRONS. Katzper, Meyer; Percus, Jerome (AEC Computing and Applied Mathematics Center, New York Univ., N. Y.). Feb. 1967. Contract AT(30-1)-1480. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Methods for improving the calculation of energy values for atoms by accounting for the interparticle correlation are presented. An approach using the projection of an intrinsic-state wave function is first studied. A formalism for the use of intrinsic-state density matrices is then presented and applied. The special properties of an oscillator-based density matrix are investigated. As a result of these considerations a special N-body coordinate transformation is applied to a Slater determinant to form a correlated wave function and its related one- and two-body density matrices. A calculation is carried out to show the improvement resulting from this approach. A harmonic atom approach with the use of unitary transformations to obtain a large class of one-body density matrices and guaranteed realizable two-body density matrices is then formulated. The formalism is tested in a calculation on helium. (auth)

18409 (ORNL-P-2911) HIGH CURRENT DC ION BEAMS. Kelley, George G. (Oak Ridge National Lab., Tenn.). [1966]. Contract W-7405-eng-26. 10p. (CONF-670307-27). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The beam systems which have been developed for use in high-energy injection experiments in thermonuclear research are described. An attempt is made to compare the quality of these beams (not the relative merit of the injection systems). Problems peculiar to the production of intense dc beams are discussed. (auth)

18410 (SC-RR-66-452) ANALYTICAL APPROXIMATIONS FOR X-RAY CROSS SECTIONS. Biggs, Frank; Lighthill, Ruth (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Analytical approximations efficient for use in computer programs are given for the photoelectric, incoherent-scattering, and energy-transfer cross sections for the range of atomic numbers $1 \leq Z \leq 100$ and in the photon energy interval $E \geq 0.1$ keV. The photoelectric approximations are based largely on experimental data at low energies, whereas at high energies they are constrained to approach the theoretical high-energy limit. The incoherent-scattering cross sections are approximated by rational functions fitted to the Klein–Nishina relations. The effect of round-off error in the usual form of the Klein–Nishina relations is also shown. Approximation parameters are given in tables. (auth)

18411 (UCRL-50001-66-1, pp 41-53) THERMODYNAMIC PROPERTIES OF MATTER. (Lawrence Radiation Lab., Univ. of California, Livermore).

Brief summaries of research on the following are presented: thermodynamic properties of simple hard-core systems, interatomic forces in Ar, the melting curve of Ar at high pressures, distribution of free paths, asympotic expansions of the Dirac density matrix, and experimental determination of the compressibility of atomic shells. (M.O.W.)

18412 (UCRL-50135) NONEQUILIBRIUM BOUND STATE POPULATIONS OF HYDROGENIC IONS IN A STEADY STATE. Grasberger, William H. (California Univ., Livermore. Lawrence Radiation Lab.). Sept. 8, 1966. Contract W-7405-eng-48. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The departures of bound-state populations of nearly hydrogenic ions from local thermodynamic equilibrium values are discussed for a gas of charge Z, density ρ, and arbitrary radiation field with no net changes in time. A practical set of equations and formulae which are used in the author's computer program CYCLE, and the methods by which this program treats a single space point with arbitrary radiation field are discussed. The situation of thermodynamic equilibrium is examined, and the special case called the noncyclic approximation is worked out. This case assumes that collisional effects are negligible and that radiative line transitions balance out, so that a given level then has its population determined by the balance between radiative ionizations from that level and recombinations to that level. The general case where collisional effects and line transitions are included, called the cyclic approximation, is considered at length and special formulae for handling the lines are derived. The energy balance equation for free electrons is worked out in detail. Numerical results from a very simple parameter study are presented graphically in terms of domains of validity for the various approximations. (auth)

18413 BINDING ENERGIES OF ELECTRONS IN POSITIVE IONS FOR STATISTICAL POTENTIALS. Shalitin, D. (Hebrew Univ., Jerusalem). Phys. Rev., 155: 20-3(Mar. 5, 1967).

Binding energies of electrons in several positive ions of some light elements and of iron are calculated for six statistical models. The models discussed are the Thomas–Fermi, Fermi–Amaldi, and Thomas–Fermi–Dirac models and three other modified models, in which the self-interaction of the electrons is explicitly treated. (auth)

18414 MULTICHANNEL RESONANCES IN THE INELASTIC SCATTERING OF ELECTRONS BY HELIUM. Chamberlain, G. E. (National Bureau of Standards, Washington, D. C.). Phys. Rev., 155: 46-51(Mar. 5, 1967).

Resonance structure due to intermediate negative-ion states has been observed in the differential cross section for inelastic scattering of electrons at zero angle in helium. Resonances were observed in all four of the $1s \rightarrow 2s,2p$ channels within the incident-energy range of 19.5 to 24 eV. (auth)

18415 ATOMIC BETHE–GOLDSTONE EQUATIONS. I. THE Be ATOM. Nesbet, R. K. (IBM Corp., San Jose, Calif.). Phys. Rev., 155: 51-5(Mar. 5, 1967).

The nonrelativistic electronic energy of Be(^{1}S) is computed by a generalization of the method of Brueckner, through the variational solution of generalized Bethe–Goldstone equations. These equations describe clusters of two, three, or four electrons interacting with the remainder of an N-electron system. The three- and four-particle terms are found to be very small, but the sum of three-particle terms is nearly 0.001 atomic units (a.u.). The computed correlation energy is –0.0921 a.u., or 98.1% of the difference between experimental total energy and computed Hartree–Fock and relativistic energies. (auth)

18416 ATOMIC BETHE–GOLDSTONE EQUATIONS. II. THE Ne ATOM. Nesbet, R. K. (IBM Corp., San Jose, Calif.). Phys. Rev., 155: 56-8(Mar. 5, 1967).

The nonrelativistic electronic energy of Ne(^{1}S) is computed by the variational solution of generalized Bethe–Goldstone (BG) equations. The sum of all two-particle net energy increments (pair correlation energies) is –0.3822 atomic units (a.u.), or 97.3% of the empirical correlation energy. The three- and four-particle net energy terms expected to be most important are computed and found to be smaller than 0.001 a.u. The computed pair correlation energies are analyzed in terms of symmetries induced in the BG equations, and are found to be represented well within the accuracy of the present calculations by the somewhat smaller number of parameters needed to characterize the L and S eigenstates of all possible eight-particle subsystems of the ten-electron Hartree–Fock reference state. (auth)

18417 COULOMB FRAGMENTATION OF MOLECULES, OBSERVED VIA THE RESONANT SCATTERING OF GAMMA RAYS. Metzger, F. R. (Franklin Inst., Swarthmore, Pa.). Phys. Rev. Lett., 18: 434-5(Mar. 20, 1967). (NYO-3525-15).

An attempt was made to establish clearly the existence of fairly large velocities associated with Coulomb fragmentation. Evidence obtained by utilizing the resonant scattering of gamma rays as the velocity-sensitive phenomenon is described. The decay of ^{65}Zn to the 1.12-MeV excited state of ^{65}Cu is well suited for such an experiment because the available neutrino momentum $p = 0.44$ mc is not sufficient to compensate for the gamma-recoil energy losses, and because Zn metal as well as several Zn compounds are readily volatilized, the metal vapor being predominantly monatomic. Since the width of the 1.12-MeV level in ^{65}Cu is known, it is possible to determine from an observed resonance-scattering counting rate the fraction of the emitted-line comprised within a 1-eV interval at the position of the absorption line. (W.D.M.)

18418 VELOCITY DEPENDENCE OF THE TOTAL CROSS SECTIONS FOR SCATTERING OF ALKALI METAL ATOMS BY RARE GASES. von Busch, Fr. (Univ., Bonn); Strunck, H. J.; Schlier, Ch. Z. Phys., 199: 518-40(1967). (In German).

The velocity dependence of the total scattering cross section has been measured for 10 different combinations of alkali metal atoms with rare gas atoms. By means of an automated fast comparison technique the precision of relative values of Q(v) can be increased to 10^{-3}. In the eight cases where Ar, Kr, or Xe is the scattering gas, undulations of Q(v) about its mean value have been observed. The precision of the method permits in these cases extraction of reliable information on the amplitude of the undulations. Use of this additional information makes it impossible to explain the experimental results with the simple, 2- or 3-parameter potentials generally used. For the Lennard–Jones (8 to 6) potential, a table of ϵr_m values is given. (auth)

18419 THE FRANCK-CONDON FACTORS AND THE r CENTROIDS OF THE YTTRIUM OXIDE ($B^2\Sigma - X^2\Sigma$) BAND SYSTEM. Murthy, B. N.; Murthy, N. S. (Univ. of Mysore, India). Proc. Phys. Soc. (London), 90: 881-3(Mar. 1967).

The calculation of the Franck–Condon factors of the bands of the yttrium oxide ($B\,^2\Sigma - X\,^2\Sigma$) system of astrophysical interest was made by the method of numerical integration using Morse wave functions. The r centroids, previously unobtained for this band system, are evaluated by the same procedure and also by the graphical method. (auth)

18420 POSITRON ANNIHILATION. Bisi, A. (Istituto di Fisica del Politecnico, Milan). Nuovo Cimento (1), 4: Suppl., 707-22(1966). (In Italian).

Recent data on the formation and annihilation of positrons and complex bound systems are reported. The increasing contribution of Italian physicists to this study is indicated. (J.S.R.)

18421 RANGE-ENERGY RELATIONS FOR LOW-ENERGY IONS. Schioett, Hans E. Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 9, 1-19(1966).

Projected ranges are calculated for low-energy light particles in heavy substances (e.g., 20-keV deuterons in gold), together with straggling in projected range, assuming randomness of stopping material. The projected range turns out to be considerably less than the range along the path, and the distribution in projected range is very broad. The range ratio $\bar{R}_p/\bar{R}$ as well as the relative straggling $\overline{\Delta R_p^2}/\bar{R}_p^2$, are independent of stopping substance when a reduced energy measure, ϵ, is used, and are not strongly dependent on the atomic number of the projectile. As an extension of earlier work, range-energy tables covering a large number of combinations of incoming particle and stopping substance are presented. (auth)

18422 BORN–OPPENHEIMER SEPARATION FOR THREE-PARTICLE SYSTEMS. II. TWO-CENTER WAVEFUNCTIONS. Hunter, G.; Pritchard, H. O. (Univ. of Manchester, Eng.). J. Chem. Phys., 46: 2146-52(Mar. 15, 1967).

Semianalytic solutions of the Schroedinger equation for the motion of a particle in the static Coulomb field of two other particles are derived in a form suitable for numerical evaluation of the expansion coefficients on an electronic computer. Relevant mathematical aspects and the numerical methods are described. Tables of two-center wave functions are made available through the American Documentation Institute. An Appendix describes some "dynamic scaling" procedures, designed to facilitate Gaussian elimination and bisection where large-order matrices are involved. (auth)

18423 BORN–OPPENHEIMER SEPARATION FOR THREE-PARTICLE SYSTEMS. III. APPLICATIONS. Hunter, G.; Pritchard, H. O. (Univ. of Manchester, Eng.). J. Chem. Phys., 46: 2153-8(Mar. 15, 1967).

The formulation of the three-body problem presented in Paper I of this series leads to a set of second-order linear simultaneous differential equations. A numerical procedure for the solution of these equations is described, and is used to compute nonadiabatic energies for the first few rotation–vibration levels of $^2\Sigma_g H_2^+$, $^2\Sigma HD^+$, and $^2\Sigma_g D_2^+$. The dipole moment of $^2\Sigma HD^+$ is given, together with matrix elements for rotation–vibration transitions. The method is also applied to obtain approximate binding energies of two-electron atoms and various mesonic systems from two-center wave functions. (auth)

18424 HYDROGEN ATOM SCATTERING: VELOCITY DEPENDENCE OF TOTAL CROSS SECTION FOR SCATTERING FROM RARE GASES, HYDROGEN, AND HYDROCARBONS. Fluendy, M. A. D.; Martin, R. M.; Muschlitz, E. E. Jr.; Herschbach, D. R. (Harvard Univ., Cambridge, Mass.). J. Chem. Phys., 46: 2172-81(Mar. 15, 1967).

An apparatus for scattering experiments with thermal-energy hydrogen atom beams is described. The atoms are generated by dissociation of H_2 in a tungsten-tube furnace at ~2700°K, modulated by a mechanical chopper, and velocity selected by deflection in an inhomogeneous magnetic field. After passing through a scattering chamber containing the target gas, the atoms strike a platinum strip bolometer, which functions as a catalytic recombination detector (capable of detecting an H beam of $\sim 5 \times 10^{10}$ atoms cm^{-2} sec^{-1}). Measurements of the velocity dependence of the total collision cross section in the range 3 to 11×10^5 cm/sec (equivalent to 0.05 to 0.5 eV) are given for scattering of H atoms from the rare gases, H_2, CH_4, C_2H_2, C_2H_4, C_2H_6, and $C(CH_3)_4$. The results show that throughout this range attractive r^{-6} interactions are still predominant for Xe, C_2H_4, and $C(CH_3)_4$ whereas repulsive interactions are dominant for most of the other gases. The data are compared with calculations based on the Lennard-Jones (n,6) potential and with empirical correlations of van der Waals force constants. (auth)

18425 COLLISION MECHANISMS OF ION–MOLECULE REACTIONS AT ENERGIES OF 1 eV. Matus, L.; Hyatt, D. J.; Henchman, M. J. (Leeds Univ., Eng.). J. Chem. Phys., 46: 2439-40(Mar. 15, 1967).

The technique presented for studying the kinematics of ion–molecule reactions at energies of ~1 eV involves the pulsing of various electrodes in a mass-spectrometer ion source and achieves velocity analysis of the ions by measuring their residence times in the ionization chamber. Experimental results are presented for the reactions $CH_3^+ + CH_4 \rightarrow C_2H_5^+ + H_2$ and $CH_4^+ + CH_4 \rightarrow CH_5^+ + CH_3$. (A.G.W.)

18426 OXYGEN QUENCHING OF POSITRON LIFETIMES IN LIQUIDS. Cooper, A. M.; Laidlaw, G. J.; Hogg, B. G. (Univ. of Manitoba, Can.). J. Chem. Phys., 46: 2441-2(Mar. 15, 1967).

Data on positron annihilation in oxygen-saturated, air-saturated, and degassed liquids are presented. Liquids studied were hexane, fluorohexane, chlorohexane, bromohexane, iodohexane, cyclohexane, and benzene. The data show that large changes occur in the long-lived lifetime for positron decay in samples containing varying amounts of oxygen. Results are consistent with the idea of the formation of positronium dioxide. (A.G.W.)

18427 A CLASSICAL IMPULSE APPROXIMATION TREATMENT OF COLLISIONAL DETACHMENT FROM H^- IONS. Bates, D. R.; Walker, J. C. G. (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 90: 333-6(Feb. 1967).

A simple formula, based on the classical impulse approximation, is given for the cross section for electron detachment collisions between fast H^- ions and neutral atoms or molecules. The utility of the formula is demonstrated by comparisons of calculated and measured cross sections. (auth)

18428 LUMINESCENCE OF GASES EXCITED BY HIGH-ENERGY RADIATION. PART 2. EMISSION SPECTRA OF MOLECULAR XENON. Brocklehurst, B. (Univ. of Sheffield, Eng.). Trans. Faraday Soc., 63: 274-81(Feb. 1967).

The emission spectra of neon, argon, krypton and xenon excited by soft x rays and the effect of pressure (up to 1 atm) are reported. The spectra of the lighter gases are dominated by emissions from trace impurities (OH, N_2). Neon gives line spectra but diffuse or continuous spectra are excited at the higher pressures in the heavier gases. Eight new features in the xenon spectrum are ascribed to Xe_2 or Xe_2^+ and their excitation mechanisms are discussed. (auth)

18429 ROTATIONAL EXCITATION OF MOLECULAR HYDROGEN. Allison, A. C. (Glasgow Univ.); Dalgarno, A. Proc. Phys. Soc. (London), 90: 609-14(Mar. 1967).

Close-coupling calculations are carried out of the 0–2 rotational excitation of H_2 by the impact of H, He, and H_2 and of the 0–2 rotational excitation of D_2 by H impact. The failure of the distorted-wave approximation at high impact energies is demonstrated. The close-coupling result for He impact at 0.15 eV differs by less than 10% from the result of a semiclassical calculation. Excitation cross sections and angular distributions and elastic cross sections are calculated. For $H-H_2$ and H_2-H_2, rate coefficients are also given. (auth)

18430 CALCULATION OF RELATIVISTIC EFFECTS IN MANY-ELECTRON HYPERFINE STRUCTURE. Coulthard, M. A. (Univ. of Melbourne). Proc. Phys. Soc. (London), 90: 615-18 (Mar. 1967).

The theory of Sandars and Beck [Proc. Roy. Soc. A, 289: 97-107 (1965)] has been tested accurately by calculating, using relativistic Hartree–Fock atomic wave functions, the relativistic quadrupole interaction constants B for the ground states of Mn and ^{151}Eu and the relativistic dipole interaction constant A for the ground state of ^{151}Eu. The results agree in sign and order of magnitude with the experimental values obtained by Sandars and Woodgate [Proc. Roy. Soc. A, 257: 269-76(1960)] and Evans et al. [Proc. Roy. Soc. A, 289: 108-13(1965a)]. (auth)

18431 ELECTRON COLLISIONS WITH IONS OF THE $3p^3$ CONFIGURATION. Czyzak, S. J.; Krueger, T. K. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Proc. Phys. Soc. (London), 90: 623-8(Mar. 1967).

Extensive calculations are being made of the cross sections for electron impact excitation of the metastable levels of the $3p^q$ (q = 2, 3, 4) configuration. These cross sections are important in the interpretation of gaseous nebulae spectra. Collision strengths are reported for ions in the $3p^3$ isoelectronic sequence. The calculations are made using an improved distorted-wave method recently formulated by Seaton. (auth)

18432 ELECTRON COLLISIONS IN OXYGEN. Daly, N. R.; Powell, R. E. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Proc. Phys. Soc. (London), 90: 629-36(Mar. 1967).

Collisions between electrons and oxygen molecules and ions have been studied using a mass spectrometer. The formation and subsequent ionization of $O^+(^4S)$, $O^+(^2D)$, and $O^+(^2P)$ to form O^{2+} has been shown to take place. Appearance potentials for O^{2+} and O^{3+} formed by electron collision with oxygen molecules have been measured, as well as the ionization potential of doubly charged oxygen. The $A\ ^3\Sigma_u^+$ state of O_2^{2+} has been detected. The Wigner spin rule has been used to explain the different charge-exchange rates between the $A\ ^3\Sigma_u^+$ and $X\ ^1\Sigma_g^+$ states of O_2^{2+} and oxygen, nitrogen, and argon gas. (auth)

18433 FORMATION OF NEGATIVE HELIUM IONS FROM FAST POSITIVE AND NEUTRAL HELIUM IN HYDROGEN. Collins, L. E.; Stroud, P. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). Proc. Phys. Soc. (London), 90: 641-8(Mar. 1967).

The equilibrium fractions of He^- produced by He^+ impact on hydrogen gas in the energy range 80 to 200 keV have been measured. The effect of hydrogen gas target thickness on the He^- fraction when formed from He^0 and He^+ has also been studied at 100 keV. The He^- fraction increases to a maximum value as the target thickness is increased and then falls to the equilibrium value. This effect is more pronounced when He^0 is the incident particle, and can be explained if the negative ion is formed from the metastable neutral particle. (auth)

18434 PHOTOELECTRON KINETIC-ENERGY ANALYSIS IN GASES BY MEANS OF A SPHERICAL ANALYSER. Frost, D. C.; McDowell, C. A.; Vroom, D. A. (Univ. of British Columbia, Vancouver). Proc. Roy. Soc. (London), Ser. A, 296: 566-79 (Feb. 14, 1967).

A spherical grid analyser was used to measure the kinetic energy distribution of photoelectrons produced by the interaction of 584 Å radiation with argon, krypton, xenon, hydrogen, HD, deuterium, oxygen, and nitrogen. The relative transition probabilities to the $^2P_{\frac{3}{2}}$ and $^2P_{\frac{1}{2}}$ levels of the rare gas ions and to various vibronic states of the other gases are given. A detailed description of the apparatus is included. It is demonstrated that the ionic energy levels measured agree extremely well with those found by optical spectroscopy, and that it will be possible, in favourable cases, to determine the bonding or antibonding nature of an ionized orbital from the shape of the photoelectron stopping curve. (auth)

18435 INTERPRETATION OF COLLISION BROADENING AND SHIFT IN ATOMIC SPECTRA. Hindmarsh, W. R. (The Univ., Newcastle upon Tyne, Eng.); Petford, A. D.; Smith, G. Proc. Roy. Soc. (London), Ser. A, 297: 296-304(Feb. 28, 1967).

The classical theory of foreign gas broadening, due to Lindholm (1945) and Foley (1946), is used to evaluate the constants C_6 and C_{12} of the Lennard-Jones potential $C_{12}r^{-12} - C_6r^{-6}$ from measurements of collision broadening and shift due to rare gases at pressures of less than one atmosphere. The values of C_6 so obtained are of the expected order of magnitude, and where measurements on one spectral line broadened by a number of rare gases are available (Smith, 1966), are found to be approximately proportional to the polarizability of the rare gas. This behavior is also exhibited by the values obtained from elastic scattering cross sections. The constants C_{12} for the short range, repulsive part of the potential are discussed, and their values for a number of pairs of atoms in which at least one member of the pair is a rare gas are found to fit an empirical formula $C_{12} = qR^{12}$, where $q = (0.9 \pm 0.3) \times 10^{-16}$ erg and R is the sum of the "atomic radii" of the two atoms, where the atomic radius is defined as the distance from the nucleus at which the radial charge density is 0.012 atomic units. The values of C_{12} extend over more than 8 orders of magnitude, and include estimates made from studies of the equation of state of rare gases, and of elastic scattering cross sections, as well as of collision broadening and shift. (auth)

18436 RADIATION ABSORPTION PHENOMENA IN GASES. I. GENERAL THEORY OF LINE BROADENING. Bezzerides, Bandel (Univ. of California, Livermore). J. Quant. Spectros. Radiative Transfer, 7: 353-71(Mar.-Apr. 1967). (UCRL-14792).

Green's function techniques are used to construct a general theory of line broadening in gases. Extensive use of the diagrammatic methods of modern field theory makes possible a useful classification of the various types of mechanisms that may broaden the absorption line. To illustrate the general formalism a generalization of the impact theory of Baranger et al. is derived in which the recoil of the atom is included; that is, collisional broadening and Doppler broadening are treated in a consistent fashion. (auth)

18437 MOBILITY OF IONS IN THE PARENT GAS. Smirnov, B. M. Zh. Tekh. Fiz., 36: 1864-71(Oct. 1966). (In Russian).

Formulas are derived for the ion drift velocity under the influence of an electric field in their parent gas. The calculations are based on the kinetic equation, and it is assumed that elastic scattering of the ions can be neglected in comparison with charge exchange collisions and that the charge exchange cross section is independent of velocity. Exact solutions of the simplified kinetic equation are obtained for the two limiting cases of low and high electric field strength, and a formula for the drift velocity in fields of intermediate strength is obtained by interpolation. The formula derived for ion mobility in weak fields is compared with the approximate formulas of Chapman and Enskog, and of Huxley and Compton; the mobilities given by both approximate formulas do not differ greatly from those given by the present "exact" formula. The drift velocities of helium, neon, argon, krypton, xenon, and cesium ions in their parent gases were computed for values of the ratio of the electric field strength to the pressure ranging from about 10 to 1000 V/cm mm Hg and the results are presented graphically, together with experimental data on the inert gases from different sources. (ATD)

18438 A MODIFICATION OF THE CLOSE-COUPLING APPROXIMATION FOR e–H SCATTERING ALLOWING FOR THE LONG-RANGE INTERACTIONS. Damburg, R.; Karule, E. (Inst. of Physics, Riga). Proc. Phys. Soc. (London), 90: 637-40(Mar. 1967).

A modified close-coupling approximation for e–H scattering is proposed, which exactly accounts for dipole and quadrupole polarization without losing the extremal properties for phase. (auth)

18439 CALCULATION OF AVERAGE RESONANCE CHARGE EXCHANGE AND ELECTRON IONIZATION CROSS SECTIONS OF AN ACCELERATED ATOMIC BEAM. Agrest, M. M.; Kursanov, Yu. V.; Labakhua, S. I.; Rikenglaz, M. M. Zh. Tekh. Fiz., 36: 1911-14(Oct. 1966). (In Russian).

A computer was used to calculate the averages over the Maxwell velocity distributions of the electron and ion velocities in a plasma target of the cross sections of the atoms in an accelerated beam striking the plasma for ionization by the plasma electrons and for resonance charge exchange with the plasma ions. The electron ionization cross section averages were calculated on the assumption that the cross section is proportional to $(I/U)\log(U/I)$, where I is the ionization energy and U is the kinetic energy of the electron in the rest system of the atom. The average cross section is proportional to the maximum cross section for ionization of the given atom by electrons and depends further only on the two parameters U_0/kT and kT/I, where T is the electron temperature of the plasma target and U_0 is the kinetic energy of an electron moving with the velocity of the incident atom beam. The results are tabulated for values of kT/I from 0.741 to 444 and for values of U_0/kT from 10^{-6} to 0.5625. The resonance charge exchange calculations were limited to the case of a hydrogen atom beam incident on a hydrogen plasma and were based on the expression $10^{-16}(7.6 - 1.06\log_{10}E)^2$ for the cross section, where E is the energy. The results are presented graphically for beam energies from 200 to 10,000 eV and plasma ion temperatures from 25 to 4000 eV. (ATD)

18440 INVESTIGATIONS ON THE ENERGY DEPENDENCE OF COLLISION PROCESSES OF NEGATIVE IONS WITH CHARGE TRANSFER. Peuckert-Kraus, K. (Physikalisches Staatsinstitut, Hamburg). Ann. Phys. (7), 18: 288-98(Nov. 1966). (In German).

The energy dependence of the effective cross section for charge transfer processes in collisions of negative ions was investigated. The energy range of the colliding primary negative ions formed by electron collisions extends from several tenths of an eV up to approximately 20 eV. All reactions investigated show, at low energies, relatively high effective cross sections ($Q \cong 10^{-15}$ cm^2) and this effective cross section decreases with increasing energy. In analogy to the charge reversal phenomena of positive ions, the charge transfer of negative ions at low energy could be traced to Coulomb dipole interactions on the basis of the polarizability and the eventual present permanent dipole moment of the molecule. (tr-auth)

18441 TRANSITION OF ELECTRON TO THE CONTINUOUS SPECTRUM. Osherov, V. I. Dokl. Akad. Nauk SSSR, 168: 1291-93(1966). (In Russian).

The motion of nuclei when one linear term interacts with the continuum is considered in the quantum formulation. The terms corresponding to the motion of the electron in the continuous spectrum are assumed to be noninteracting with one another and to have zero slope. The system of quantum equations for the motion of the nuclei under this condition is solved in the momentum representation. The solution shows directly that no free electrons with energy larger than the energy of the nuclei participating in the process can be produced. Expressions are obtained for the total probability of electron detachment as a function of the energy of the nuclei, which is shown to have an anomalous behavior. The probability has a maximum at an energy approximately equal to 0.6 of the binding energy, and a resonant character at small distances from the maximum. When the masses of the colliding nuclei are nearly equal, the energy of the incoming atom must slightly exceed the binding energy of the electron in order for the resonance to be observed. Since such an anomalous behavior of the probability is also obtained with other computational models, it is proposed that it can be observed experimentally. (ATD)

18442 EFFECTIVE CROSS SECTIONS OF DEPOLARIZING COLLISIONS. I. CALCULATION OF THE EFFECTIVE CROSS SECTIONS FROM MEASUREMENTS OF THE DEGREE OF POLARIZATION. Ermisch, W. (Humboldt-Univ., Berlin). Ann. Phys. (7), 18: 271-87(Nov. 1966). (In German).

Cross sections were calculated after measurements of the degree of polarization. Under simplifying assumptions and certain approximations, equations were derived which make it possible to determine, from the size of the measured degree of polarization of the resonance fluorescence of an atomic vapor, the collision

numbers and the collision cross sections for depolarizing collisions which occur from a foreign gas being introduced. The effect of the experimental installation and the influence of simultaneously occurring effects such as radiation scattering, quenching collision, phase perturbation collisions, and anisotropy of the fluorescence decay time were considered. (tr-auth)

18443 SHORT-RANGE FORCES OF INTERMOLECULAR INTERACTION OF OXYGEN AND NITROGEN. Belyaev, Yu. N.; Leonas, V. B. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 170: 1039-40(1966). (In Russian).

In view of recent interest in the study of elastic scattering of nitrogen and oxygen molecules in their own gas and by atoms of noble gases, the parameters K and s of the intermolecular-interaction potential function $V(r) = K/r^s$ were determined from the energy dependence of the total effective cross section of a beam of fast neutral molecules of nitrogen and oxygen (E = 0.6 to 4 keV) in oxygen, nitrogen, and argon. A table listing these parameters and a plot of the resultant potential curve for the O_2-O_2 interaction are presented. The latter is compared with potential curves obtained by others. The curve obtained from data on the relaxation of the molecule vibrations in the gas agrees poorly with the present results, in view of deficiencies in the present theory of vibrational relaxation. Comparison with refined calculations on the basis of a semiempirical method produced better agreement. (ATD)

18444 COHERENT BREMSSTRAHLUNG AND PAIR PRODUCTION IN THE DIAMOND CRYSTAL IN GRAPHICAL REPRESENTATION BETWEEN 1 AND 40 GeV. Lutz, G.; Timm, U. (DESY, Hamburg). Z. Naturforsch., 21a: 1976-87(Nov. 1966).

Numerical information is reported on coherent effects of bremsstrahlung and electron pair production in diamond crystals in the energy range from 1 to 40 GeV. The information is collected in a number of graphs and tables showing the intensity and polarization of bremsstrahlung and the cross section and asymmetry ratio for pair production as a function of crystal orientation. The basic formulas for the interpretation of the diagrams are given. The experimental problem of a precise orientation of the crystal, which is closely connected with the production of coherent radiation, is discussed on the basis of these formulas. (auth)

18445 CONCERNING ONE POSSIBLE MECHANISM OF PRODUCTION OF THE MESIC-MOLECULAR ION $(dd\mu)^+$. Vesman, E. A. (Inst. of Physics and Astronomy, Academy of Sciences, Estonian SSR). JETP Lett. (USSR) (Engl. Transl.), 5: 91-5 (Feb. 15, 1967).

There is great disparity between the experimentally obtained rate of $(dd\mu)^+$ production and the theoretical estimates. It seems that this occurs because $(dd\mu)^+$ has a level K = 1, ν = 1 with low binding energy. The binding energy obtained for this state in the adiabatic approximation is $|E_d| = 7$ eV. Although variational calculations do not yield this level, they do not contradict its existence. Assuming that $(dd\mu)^+$ has the level k = 1, ν = 1, the mechanism of $(dd\mu)^+$ formation by means of an E1 transition with transfer of the binding energy to the excited vibrational levels of the D_2 molecule is considered. (W.D.M.)

18446 TOTAL SCATTERING CROSS SECTIONS OF HYDROGEN AND DEUTERIUM BY HELIUM. Moore, George E.; Datz, Sheldon; van der Valk, Fred (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. J. Chem. Phys., 46: 2012-13(Mar. 1, 1967). (ORNL-P-2682).

Total collision cross sections were measured using average relative beam velocities of 1.17 to 2.64×10^5 cm/sec for $H_2-{}^3He$, 0.98 to 1.92×10^5 cm/sec for $D_2-{}^3He$, and 1.11 to 1.90×10^5 cm/sec for $H_2-{}^4He$. The dependence of the cross sections on velocity is discussed. The hydrogen–helium cross sections were found to be considerably smaller than previously reported values. The $^4He-{}^4He$ cross section was also measured at 300°K and found to be 33 ± 2 Å^2. (A.G.W.)

18447 CLASSICAL CALCULATION OF ATOMIC SCATTERING PARAMETERS. Bingham, Felton W. (Sandia Lab., Albuquerque, N. Mex.). J. Chem. Phys., 46: 2003-4(Mar. 1, 1967).

A set of tables was compiled to provide values of three parameters important in studies of atomic collisions: (1) the distance of closest approach of the colliding atoms, (2) the impact parameter for the collision, and (3) the differential cross section for the collision. Calculations were made from the exponentially screened Coulomb potential $V(r) = (Z_1Z_2e^2/r) \exp(-r/a)$, where Z_1 and Z_2 are the atomic numbers of the colliding atoms, e is the electronic charge, r is the distance between the two atomic nuclei, and a is the electron-screening length. Values of the three parameters are provided at smaller intervals in scattering angle and in incident energy than in previously available tables. (A.G.W.)

18448 CORRELATION OF INFRARED AND INELASTIC NEUTRON SCATTERING SPECTRA. Agrawal, Ashok K.; Yip, Sidney (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys., 46: 1999-2000(Mar. 1, 1967).

An equation is given which provides a connection between infrared band shape and the energy distribution of inelastically scattered slow neutrons. The equation was used to calculate the energy distribution of neutrons scattered from liquid methane. A Langevin description of translational motions was assumed. The calculation was found to depend on the dynamical friction constant η. When calculated cross sections were compared with experimental measurements, a value of $\eta = 4 \times 10^{12}$ sec^{-1} was found to give a good fit with the data. (A.G.W.)

18449 DRIFT VELOCITIES OF SLOW ELECTRONS IN METHANE, ETHANE, ETHYLENE, PROPYLENE, ACETYLENE, AND 1-BUTENE. Bowman, C. R.; Gordon, D. E. (General Dynamics/Fort Worth, Tex.). J. Chem. Phys., 46: 1878-83(Mar. 1, 1967).

A double-shutter drift tube was used to measure the drift velocities of electrons in methane, ethane, ethylene, acetylene, propylene, and 1-butene for low E/P values. The data were analyzed to obtain values of the momentum transfer cross section as a function of electron energy in the interval 0.010 to 0.063 eV. Cross sections were obtained by fitting a power series in electron velocity to the slope of electron-drift-velocity data in the thermal equilibrium range where electron velocities can be represented by a Maxwellian distribution. (auth)

18450 ISOTOPE SHIFTS AND NUCLEAR CHARGE DISTRIBUTIONS. Stacey, D. N. (Oxford Univ.). Rep. Progr. Phys., 29: 171-215(1966).

The measurement and interpretation are discussed for the field-dependent isotope shifts in atomic spectra, i.e., shifts due to variations in the nuclear charge distribution. Mass effects are considered only in order to extract the field-dependent shifts from the measured shifts. After a review of experimental techniques and a summary of the basic theory, the isotope shift results are discussed in terms of the results of other experimental investigations of nuclear charge distributions. There are two striking features of isotope shift results for even–even nuclei, their overall smallness and their irregular variation with neutron number over the range of isotopes of an element. The first of these has not yet been satisfactorily accounted for. The irregularities are associated with neutron shell structure, but they cannot be attributed entirely to deformation effects. Experimental isotope shifts and nuclear deformations are tabulated. Recent work on the odd–even staggering effect is reviewed. (auth)

18451 QUASIPARTICLE-ENSEMBLE THEORY FOR A NORMAL FERMI LIQUID. Mohling, F. (Univ. of Colorado, Boulder); Tuttle, E. R. Phys. Rev., 153: 263-8(Jan. 5, 1967).

A quasiparticle ensemble (Q ensemble) is constructed in which the number of quasiparticles with momentum k in the ensemble is conserved. The thermodynamic properties of this ensemble are related to those of the grand canonical ensemble. By comparison with explicit microscopic predictions of the theory, it is shown that this formulation is necessary if the third law of thermodynamics is to be satisfied, and that in this case, the Landau theory of a Fermi liquid follows as a natural consequence. (auth)

18452 SINGLE-PARTICLE STATES OF AN ELECTRON-ION GAS IN THE RANDOM-PHASE APPROXIMATION. Zachary, W. W. (Univ. of Maryland, College Park). Phys. Rev., 153: 187-200(Jan. 5, 1967).

The formulation of quantum statistical mechanics by means of Green's functions or propagators is used to discuss some new results for the electron–ion gas in the random-phase approximation. The theory is formulated in terms of the density variation, the difference between the mean density and the equilibrium value, which is nonvanishing because of the existence of an external field. This method is closely associated with the more familiar formulation in terms of current–current correlation functions. The contribution from the single-particle states occurs in two forms—the particle-hole continuum and the "exchange effect" between noninteracting particles. The density variations and "relaxation times" of these contributions are derived and discussed in detail. It is shown that the "exchange effect" is not an exchange effect at all since the results for this contribution are derivable on the basis of classical theory. This situation is also discussed in detail. The hierarchy of relaxation times for the various contributions to the density variation is considered. It is shown that the hierarchy has structure for collective states different from that for single-particle states. (auth)

18453 SINGLE- AND DOUBLE-QUANTUM PHOTODETACHMENT OF NEGATIVE IONS. Robinson, E. J.; Geltman, S.

(Joint Inst. for Lab. Astrophysics, Boulder, Colo.). Phys. Rev., 153: 4-8(Jan. 5, 1967).

The recent measurement of the transition probability for the double-quantum detachment of an electron from I^- has prompted a new theoretical study of this problem. A central-field model for bound and free states is used, in which a parameter is adjusted in the potential to yield the observed binding energies of the negative ions. An implicit-sum method, requiring the solution of inhomogeneous radial equations, is used to evaluate the sums over intermediate states. The results for I^- lie almost within the experimental uncertainty. The cross sections for single-quantum photodetachment and electron elastic scattering (from the neutral atom) are also given for the ions studied: C^-, O^-, F^-, Si^-, S^-, Cl^-, Br^-, I^-. (auth)

18454 ELASTIC SCATTERING OF ELECTRONS BY ATOMS. Mittleman, Marvin H. (Univ. of California, Livermore). pp 283-315 of Advances in Theoretical Physics. Vol. I. Brueckner, Keith A. (ed.). New York, Academic Press, 1965.

The equivalent potential method applied to the problem of the scattering of a charged particle by a neutral atom is discussed. A general formulation is presented and the equivalent potential is discussed in the adiabatic approximation. A variational principle is also used to obtain a more accurate representation of the series for the equivalent potential. Numerical results are presented for electron scattering on neon. (M.O.W.)

18455 IONIZATION CROSS SECTIONS OF THE ELEMENTS CALCULATED FROM MEAN-SQUARE RADII OF ATOMIC ORBITALS. Mann, Joseph B. (Los Alamos Scientific Lab., N. Mex.). Contract W-7405-eng-36. J. Chem. Phys., 46: 1646-51(Mar. 1, 1967). (LA-DC-8327).

Relative ionization cross sections for single ionization by electron impact on free gaseous atoms have been calculated by utilizing a summation of the mean-square orbital radii of outer electrons. A previous calculation of the cross sections by Otvos and Stevenson was in only fair agreement with experimental data owing to the use of incorrect mean-square radii and to the method of summation of electron-shell contributions to the total cross sections. Hartree-Fock calculations of orbital wave functions have been carried out for all of the elements. Mean-square radii of atomic orbitals from the Hartree-Fock calculations were corrected approximately for relativistic effects. The ionization cross sections obtained from the summations were normalized at argon and compared with experimental values. The computed maximum cross sections are an improvement over past theoretical values. (auth)

18456 DISSOCIATIVE CHARGE EXCHANGE OF RARE-GAS IONS WITH C_2F_6 AND C_3F_8. Smith, Dave; Kevan, Larry (Univ. of Kansas, Lawrence). Contract AT(11-1)-1528. J. Chem. Phys., 46: 1586-97(Mar. 1, 1967). (COO-1528-8).

Dissociative charge exchange of rare-gas ions with C_2F_6 and C_3F_8 has been studied. The data were obtained with a single-stage Nuclide mass spectrometer by operating the ion source in the Čermák-Herman mode. A charge-transfer mass spectrum was obtained for C_2F_6 and C_3F_8 with each rare-gas ion except Xe. The relative ionic abundances were interpreted as portraying the dissociation of $C_2F_6^+$ and $C_3F_8^+$ as a function of their excitation energy. The normalized abundance of CF_3^+ as a function of excitation energy shows two maxima, which indicates that two processes contribute to CF_3^+ formation from C_2F_6 and C_3F_8. (auth)

18457 ELECTRONIC INTERACTION INTEGRALS FOR ATOMS CALCULATED WITH LAGUERRE POLYNOMIAL RADIAL WAVEFUNCTIONS. Brown, Robert T. (Univ. of Michigan, Ann Arbor). Contract AT(11-1)-1112. J. Chem. Phys., 46: 1551-2 (Mar. 1, 1967).

Straightforward evaluation of electronic interaction integrals for many-electron atoms using Laguerre polynomial radial wave functions leads to sums of differences of large numbers. An alternate formulation is presented, which does not have this disadvantage. (auth)

18458 REFLECTION OF FAST IONS FROM A DENSE MEDIUM AT GLANCING ANGLES. Firsov, O. B. Dokl. Akad. Nauk SSSR, 169: 1311-13(Aug. 21, 1966). (In Russian).

The velocity distribution of the reflected ions is determined when the incident ions have energies much greater than the binding energy of the reflecting medium, so that the principal role in the scattering is played by near-Coulomb interactions, corresponding to scattering at very small angles. The solution of the kinetic equation is obtained in this case by replacing the collision integral by an angular Laplace operator describing the directional diffusion of the particle velocity vector, and by a term describing the uniform deceleration of the particles. It is shown that the maximum distribution corresponds to the specular-reflection angle and that the form of the distribution does not depend on the concrete scattering mechanism, provided small-angle scattering prevails. (ATD)

18459 MEASUREMENT OF THE LOW ENERGY RESONANT CHARGE EXCHANGE CROSS SECTION OF POTASSIUM AND CESIUM. Dittner, Peter F. New York, New York Univ., 1965. 58p.

Thesis.

A measurement has been made of the resonant charge-exchange cross section of potassium ions incident upon potassium atoms, and cesium ions incident upon cesium atoms. Incident ion energies ranged from ten eV to two hundred eV, and the target atoms had thermal energies. The ions are produced, accelerated, and charge exchanged in the same chamber. An opening in the chamber allows some of the ions, thermal-energy atoms, and resulting high-energy atoms to escape into the surrounding vacuum. These three components of the beam, the temperature of the chamber, and various geometric factors were measured and the cross section was determined. The charge-transfer cross section (assuming constant detector efficiency equal to one hundred percent) varies from 1.13×10^{-14} cm^2 (at 10 eV) to 1.99×10^{-14} cm^2 (at 200 eV) for potassium, and from 2.04×10^{-14} cm^2 (at 10 eV) to 3.26×10^{-14} cm^2 (at 160 eV) for cesium. The magnitude and velocity dependence of the cross section agree and disagree, respectively, with both theoretical and previous experimental investigations. The anomalous velocity dependence is ascribed to an energy-dependent efficiency of detection due to various surface phenomena that occur when high-energy alkali atoms interact with a surface ionization detector. (Dissertation Abstr.)

18460 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS BY NONSPHERICAL ATOMS. Snodgrass, Herschel Byron. Berkeley, Calif., Univ. of California, 1966. 162p.

Thesis.

The problem of the quasi-elastic scattering of low-energy electrons by atoms is investigated in the cases where the atom's ground state configuration contains incomplete "p" or higher "l" shells. The range of energies considered is such that where as a result of the scattering the atom's total angular momentum may be changed, the atom's total energy in the Hartree-Fock approximation cannot. An optical model potential is derived that is a matrix in the atomic angular momentum states and a noncentral operator in the scattered electron's coordinates. A detailed discussion is given for the first two orders of the perturbation expansion of this potential for atoms having one or two electrons in the open shells and the extension to more complex cases is outlined. It is found that the lowest order represents the effects of the atom's static charge moments and that the second order represents the effects of the various possible atomic polarizabilities. Terms in the potential which represent exchange scattering are also derived. When the optical potential is projected onto the invariant subspaces of fixed total angular momentum for the system, ordinary integro-differential equations are obtained which couple the partial wave amplitudes of the scattered electron. The coupling coefficients are derived directly from the theory of angular momentum: for the direct interaction it is seen that the orbital angular momenta of the atomic electrons should first be coupled together and then that the resultant should be coupled to the angular momentum of the scattered electron to form the total, but for the exchange interaction the momenta must be recoupled in such a way that the momenta of the exchanged electrons are first coupled together and then this resultant is coupled to the momentum of the remainder of the atom. This results in a difference between the coupling coefficients for the direct and exchange interactions; however the coupling coefficients are identical for all orders of the direct interaction if the potential is assumed velocity independent. The determination of the scattering amplitude in terms of the optical model potential is also discussed, and particular attention is given to the application of variational principles. The Kohn variational principle is formulated in detail and it is found that its extension to noncentral and nonlocal problems is straightforward. A sample calculation is performed for the case of scattering by a boron atom. Finally, the limits of low energy and of large total angular momentum are considered, and estimates are given for the errors incurred by neglecting magnetic and other higher order interactions. (Dissertation Abstr.)

18461 VARIATIONAL LOWER BOUNDS ON ELECTRON HYDROGEN s-WAVE PHASE SHIFTS. Henry, Paul Maxwell. New York, New York Univ., 1966. 72p.

Thesis.

The variational bound (or minimum principle) formulation for single-channel scattering was applied to the calculation of rigorous lower bounds on the s-wave phase shifts for the scattering of electrons by hydrogen atoms (e^-H) for energies below the excitation threshold. This method was previously applied to positron-hydrogen (e^+H) elastic scattering. Because of the exchange effect in the e^-H case a projection operator is employed which projects

out of the wave function those states in which either or both electrons are in the ground state. The method requires the exact solution of the static equation, and of the corresponding static Green's function, G^P. G^P is expressed in terms of the solution of an integral equation which is solved numerically. Trial functions are chosen which are spatially symmetrized (or antisymmetrized) and correspond to states of the hydrogen atom of given angular momentum quantum number, l, with l running from zero to four. The associated radial functions contain both linear and nonlinear variational parameters, and includes some of the effects of many different nl states, where n is the principle quantum number. Values of the phase shifts for the singlet and triplet cases were obtained for several energies. The singlet phase shifts represent rigorous lower bounds, since the effect of the Green's function was included. The values obtained were compared with the results of other methods, and are seen to agree well with the most accurate of these, the Kohn type variational used by Schwartz. It was found that the e^-H calculations yield much more accurate results for a given number of parameters than the e^+H calculations. (Dissertation Abstr.)

18462 INTERATOMIC REPULSIVE POTENTIALS AT VERY SMALL AND INTERMEDIATE SEPARATIONS. Abrahamson, Adolf A. New York, New York Univ., 1960. 96p.

Thesis.

Using a minimal and a maximal principle, respectively, two approximate expressions for the interaction potential between atoms are given such that their mean, $\bar{U}(R)$, differs from the exact value, U_0, in the Thomas–Fermi–Dirac (TFD) approximation, by not more than 4% for the case of a two-center system; and by not more than 14%, in the Thomas–Fermi (TF) approximation, for the case of a three-center system. An approximate method for introducing correlation effects into the TFD model is indicated. An estimate of the magnitude of this correction, however, shows it to be less than 1% of the total electron energy, and thus generally negligible. Applications of the interaction potential $\bar{U}$ to several specific two-center systems show that: (1) For very small separations of less than $\sim 0.3\ a_0$, $\bar{U}$ agrees well with other theoretical curves and with experiment. (2) In the intermediate range from $\sim 0.3\ a_0$ to $\sim 2\ a_0$, $\bar{U}$ is found to be in better agreement with other theoretical and experimental curves than is either Bohr's screened Coulomb potential or that based on the TF approximation. (3) For separations lying between $\sim 2\ a_0$ and $\sim 2.85\ a_0$, the same remarks apply as those concerning the preceding interval if extrapolations of $\bar{U}$ are considered. (4) At separations exceeding the radius r_b of the corresponding TFD atom, $\sim 2.85\ a_0$ on the average, the expression for $\bar{U}$ becomes inapplicable. (Dissertation Abstr.)

18463 COLLISION-INDUCED DISSOCIATION OF D_2^+ IONS BY ARGON AND NITROGEN. Champion, Roy Lunsford Jr. Gainesville, Fla., Univ. of Florida, 1966. 75p.

Thesis.

The reactions $D_2^+ + X \rightarrow D + D^+ + X$, where X is Ar or N_2, were studied with an angular ion scattering apparatus at ion laboratory energies in the range $5 < E_0 < 120$ eV. Kinetic energy distributions as well as angular distributions of the product D^+ ions were determined. The experimental method consisted essentially of directing a well collimated, mass analyzed, and energy selected ion beam into a scattering region, and analyzing the product ions with a radio-frequency mass filter and a 120° electrostatic velocity selector. The product ion analysis and detection system rotate about the center of the scattering region, thereby giving information as to the angular distribution of the product ions. The results indicate that the most probable reaction channel for the collision-induced dissociation reaction is one in which primary D_2^+ ions with large vibrational energies give rise to D and D^+ products which separate with very small relative velocities. The observations are discussed in terms of a two-step collision model, where the D_2^+ ion is first electronically excited to the antibonding $^2\Sigma_u$ state, and then dissociates. (Dissertation Abstr.)

18464 MEASUREMENT OF THE EXCHANGE CROSS SECTION FOR THE SCATTERING OF ELECTRONS BY POTASSIUM ATOMS AND THE DEVELOPMENT OF AN ATOM RECOIL METHOD FOR PERFORMING SCATTERING EXPERIMENTS. Rubin, Kenneth. New York, New York Univ., 1959. 147p.

Thesis.

A direct observation of the differential exchange cross section at various angles and voltages has been made, and an atom-beam recoil technique for performing scattering experiments has been developed. The method used involves the cross firing of an atom beam and electron beam with the scattering data obtained by observing the scattered atoms. Measurements were made within the voltage range from 0.5 to 10 volts. The total cross section is obtained by keeping the atom detector fixed at the center of the unscattered atom beam and measuring the decrease in detector signal when the electron gun is turned on. The differential cross sections are obtained by displacing the detector in a direction perpendicular to the direction of the unscattered atom beam, and measuring the scattered atom current at various angles. From the observed scattered atom currents the differential cross section $\sigma(\theta)$ in terms of the electron scattering angles is obtained. It is shown that with this technique differential cross section measurements can be made at very small angles. The differential exchange cross section is obtained by first polarizing the atom beam before it enters the scattering region and then measuring the amount of depolarization of the scattered atom beam at various angles. The polarization of the incoming atom beam and the analysis of the polarization of the scattered atom beam are accomplished by means of the deflection of the atoms in inhomogeneous magnetic fields. Estimates are made of the upper and lower limits for the total exchange cross section at various voltages. For example, at .5 volts, the exchange cross section Q_e is estimated to lie within the range $100\pi\bar{a}_0^2 < Q_e < 200\pi\bar{a}_0^2$. (Dissertation Abstr.)

18465 SCATTERING OF SLOW ELECTRONS FROM THE NITROGEN MOLECULE. Sheppard, Ronald John. Washington, D. C., Howard Univ., 1966. 83p.

Thesis.

The calculation of the total elastic scattering cross section of low-energy electrons from 0 to 40 eV by molecular nitrogen is reported. The method is to combine the models of Fisk and Stier with Burrow's numerical integration technique. This procedure is then applied for an axially symmetric field potential, representing N_2, which is much simpler than those considered in the literature. The screening constant for the molecular model is also derived and compared with that of Fisk and Stier. The screening is found to be stronger in the present case for small values of the molecular field parameter ϵ_0, but decreases very quickly for larger values. The simplified field thus offers solutions that hold only for molecules whose potential form decreases more quickly than that of Fisk. The elastic scattering cross section obtained has a finite value at zero energy, which is in good agreement with that of Fisk. The large elastic peak in the vicinity of 2 eV is also reproduced. For energies approaching 40 eV, the elastic scattering for the simplified field decreases more rapidly than that of Fisk. The explanation proposed is based on the small cross-sectional area for elastic scattering as a result of the small molecular size. A comparison of the cross section with some experimental data is also made. The framework for a generalized axially symmetric field potential is discussed in an effort to satisfy the more restricted boundary conditions proposed by Fisk and Stier and to develop a clearer molecular picture. A generalized expression is derived for the charge distribution within and the screening constant for the molecule. The screening constant for atomic nitrogen derived from specific parameters of the generalized field is compared with that calculated by Slater's rules. A calculation of the elastic scattering cross section is performed for specific values of the molecular parameters; there is found to be good agreement with previous work when the screening of the πd and δP scattering is made stronger in the low-energy region than for the other scattering terms. A plot of the higher-order cross sections versus energy of incident electrons for various screening constants indicates that only the πd and δP scattering are appreciably affected. (TSS)

18466 EXCITATION OF MERCURY ATOMS BY ELECTRON IMPACT. Anderson, Richard John. Norman, Okla., Univ. of Oklahoma, 1966. 113p.

Thesis.

Optical excitation functions for 40 transitions of the mercury spectrum were obtained under conditions of low pressure and low electron-beam current. Absolute measurements of the effective cross sections were obtained through a direct comparison with a calibrated tungsten ribbon lamp. Measurements carried out for transitions within the wavelength range 365.0 to 1128.7 nm yielded values within the range 1.0×10^{-20} to 2.5×10^{-17} cm² at an electron energy of 15 eV. The measurements were used in conjunction with the theoretical transition probabilities to obtain a comparison between the experimental and theoretical intensity ratios of lines originating from a common upper level. The transition probabilities for the (6s) (np) and (6s) (6d) configurations were obtained from an analysis of the fine structure, and from the experimental g values. In addition estimates of the direct excitation cross sections of the 6^3D_3, 6^3D_2, 7^3P_2, and 7^1S_0 states were obtained at an electron energy of 15 eV. The populations of the 6^3D_3 and 7^3P_2 levels were not appreciably influenced by cascade transitions, which constituted but a few percent of their total cross sections. The direct cross sections of the 6^3D_3 and 7^3P_2 states were determined as $(7.5 \pm 1.9) \times 10^{-18}$ and $(2.5 \pm 0.8) \times 10^{-18}$ cm² respectively. Both cross sections exhibited good agreement with the respective theoretical values of 8.8×10^{-18} and 3.7×10^{-17} cm². The 6^3D_2 level is characterized by a direct cross section of $6.6 \times$

10^{-17} cm² (at an energy of 15 eV), which is approximately 4 times larger than the corresponding theoretical value of 1.8×10^{-17} cm². Contributions to the population of the 7^1S_0 level by cascade transitions constitute a major portion of the total cross section. The magnitude of the cross section was observed to be very sensitive to the values of the mixing coefficients. The limits of the variation, introduced by the range of the mixing coefficients, were reduced through observation of the $7^1S_0 - 6^1P_1$ transition. The direct cross section obtained varied from 3.8×10^{-18} to 5.3×10^{-19} cm² at 15 eV. This value was in disagreement with the theoretical value of 1.1×10^{-16} cm². (TSS)

18467 A STUDY OF VIBRATIONAL EXCITATION OF MOLECULES AND TRANSITIONS BETWEEN THE SPIN MULTIPLETS OF ATOMIC OXYGEN INDUCED BY ELECTRON COLLISION. Breig, Edward Louis. Norman, Okla., Univ. of Oklahoma, 1966. 209p.

Thesis.

Vibrational excitation cross sections of diatomic molecules by electron impact have been calculated with the Born approximation by including the polarization interaction between the incident electron and the target molecule. Because of uncertainties regarding the form of the polarization interaction close to the molecule, it is necessary to adopt an empirical model with a cut-off parameter designed to prevent divergence difficulties at the origin. Four accepted models are investigated; the vibrational excitation cross sections are shown to be not very sensitive to the particular model nor to reasonable variations in the value of the cut-off parameter. Pertinent molecular parameters are evaluated from the experimental results of Raman intensity measurements. For nonpolar molecules, such as H_2 and N_2, the inclusion of the polarization term increases the vibrational excitation cross sections by an order of magnitude or more above prior theoretical calculations, and results in much better agreement with existing experimental data. For the CO molecule, the contribution from the polarization potential is found to be comparable to that of the monopole–dipole interaction. The cross sections for excitation by electron impact have been calculated for transitions between the spin multiplets of the ^3P state in the ground configuration of neutral atomic oxygen. The calculations are performed using the continuous-state Hartree–Fock formulation with partial wave analysis in a coupled representation characteristic of the total angular momentum of the system. The systems of equations associated with the s-wave display exchange coupling only, and each set can be uncoupled by transformation under an exact resonance approximation. Individual differential equations are solved by numerical iteration. A brief study is made of the effects of polarization upon these cross sections. Calculations have been performed for electron energies in the range of 500 to 10,000°K. The final cross sections exceed the rough estimates employed in recent astrophysical calculations, and strengthen the contention that neutral atomic oxygen should be considered as contributing a significant role in the cooling rates for the interstellar media. (TSS)

18468 SPIN-DEPENDENT PROPERTIES OF A FERMI LIQUID. Wessely, Robert Michael. New Brunswick, N. J., Rutgers State Univ., 1966. 82p.

Thesis.

Expressions are derived for the paramagnetic susceptibility and the nuclear spin relaxation rate in a metal from a microscopic point of view using the many-body methods of quantum field theory. In this way it is possible to include the effects of electron–electron interactions and impurity scattering. The Landau (Fermi liquid theory) expression for the paramagnetic susceptibility of the electron gas is derived, exact to all orders in the interparticle interaction. A general expression is derived for the relaxation rate in terms of the time-ordered spin correlation function. This correlation function is evaluated in the random phase approximation for Coulomb many-body effects and for dilute impurity scattering. It is shown that the impurity correction is extremely small. Finally, it is concluded that experimental deviations from the Korringa prediction must come from other sources, perhaps spin–orbit coupling, core polarization, or lattice relaxation. (Dissertation Abstr.)

Cosmic Radiation

Refer also to abstracts 17833 and 18513.

18469 (AD-635525) THE STUDY AND INVESTIGATION OF NEUTRONS PRESENT ABOVE THE ATMOSPHERE IN NEAR-EARTH SPACE. Final Report, June 1, 1963–January 31, 1966. Martin, J. P.; Mead, J. B. (Martin Co., Baltimore, Md. Research Inst. for Advanced Studies). Mar. 1966. Contract AF 19(628)-3253. 77p. (AFCRL-66-206). CFSTI $3.00 cy, $0.65 mn.

The density of neutrons above the atmosphere was measured by a pair of BF_3 proportional counter systems aboard a polar orbiting satellite. The shape of the latitude variation of the measured density (10:1 between poles and equator) was consistent with theoretical predictions, but the measured absolute values were about three times higher. Since neutrons in the vicinity of earth are produced by cosmic ray interactions, instrumentation was developed to measure the poorly known heavy element component of the cosmic radiation. A large area scintillator–Cherenkov telescope with a geometric factor of 176 sq cm stearadian was developed in prototype for measurements from high altitude baloons. The principal difficulty in developing a telescope with large aperture (necessary for good counting statistics) is maintaining good pulse height resolution. This was solved for Cherenkov detector with a technique of optical trimming of the photomultiplier cathods. A number of detection schemes for high energy neutrons were investigated including a proton recoil detector, a C 12-3 alpha detector, and bismuth fission detectors. The conclusion of this study is that a compact multiplate fission ionization chamber would be more practical than a bismuth loaded liquid scintillator. (TAB)

18470 (AECL-2664) COSMIC RAY NM-64 NEUTRON MONITOR DATA–V. Monthly Graphs, January 1966–December 1966. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan. 1967. 79p. (CRGP-1253). Dep. mn. CFSTI $3.00 cy, $0.65 mn. AECL $2.00.

Uncorrected and barometer-corrected results from the cosmic ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from September to December 1966. Normalized graphs are given for the period January 1966 to December 1966. A warning about a spurious annual variation is included. (auth)

18471 (AD-647122) VARIATIONS OF COSMIC RAYS AND STUDY OF THE COSMOS. Dorman, L. I. Translated from pp 1-1026 of Variatsii Kosmicheskikh Luchey i Issledovaniye Kosmosa, Izdatel'stvo Akademii Nauk, Moscow, 1963. 1467p. (FTD-MT-64-86). CFSTI $3.00 cy, $0.65 mn.

This document is a machine translation of a Russian text. The machine output has been post-edited to correct for major ambiguities of meaning, words missing from the machines dictionary, and words out of the context of meaning. The sentence order has been partially rearranged for readability. The present monograph is dedicated to questions of research of the cosmos on the basis of study of variations of cosmic rays. It can be considered as a continuation of the authors' book "Variation of Cosmic Rays," issued at the beginning of the IGY. (W.D.M.)

18472 (UCRL-Trans-1340) THE STUDY OF HIGH AND SUPERHIGH ENERGY COSMIC RAY PARTICLES AND THEIR CHEMICAL COMPOSITION IN THE DOMAIN OF VERY HEAVY NUCLEI ABOARD THE SCIENTIFIC SPACE STATIONS "PROTON-1" AND "PROTON-2." Volodichev, N. N.; Grigorov, N. L.; Nesterov, V. E.; Rapoport, I. D.; Savenko, I. A.; Skuridin, G. A.; Titenkov, A. F. Translated for Univ. of California Lawrence Radiation Lab., Berkeley, from Report on All-Union Conference on Cosmic Rays, Alma-Ata, October 1966. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $7.60 fs, $2.36 mf.

The energy spectra of all particles in the energy range of 4×10^{10} to 2×10^{14} eV was measured. It can be described by the law $N(\geq E) \sim E^{-\gamma}$ with $\gamma = 1.73^{+0.1}_{-0.1}$. The energy spectra of protons in the energy range of 10^{10} to 10^{13} eV was measured. When $10^{10} < E < 10^{12}$ eV, the proton spectra is similar to the spectrum of all particles. In the energy range $2 \times 10^{12} < E < 10^{13}$ eV, the exponent of the integral proton spectrum is $\gamma \sim 2.6$. The effective cross section of the inelastic interaction of protons with carbon nuclei was measured in the proton energy range of 10^{10} to 10^{12} eV. The abundance of superheavy nuclei with $Z \geq 30$, $Z \geq 40$, and $Z \geq 48$ was measured. It was shown that the energy spectrum of nuclei with $Z \geq 40$ and $Z \geq 48$ in the energy range of several BeV/ nucleons is similar to the spectrum of He nuclei in the same energy range. (M.O.W.)

18473 MUON INTENSITIES AND ANGULAR DISTRIBUTIONS DEEP UNDERGROUND. Menon, M. G. K. (Tata Inst. of Fundamental Research, Bombay); Naranan, S.; Narasimham, V. S.; Hinotani, K.; Ito, N.; Miyake, S.; Creed, D. R.; Osborne, J. L.; Pattison, J. B.; Wolfendale, A. W. Proc. Phys. Soc. (London), 90: 649-56(Mar. 1967).

Recent measurements of the intensity of muons below 3000 mwe (metres water equivalent) underground have been combined to give an estimate of the depth-intensity relation and the angular distribution for atmospheric muons down to a maximum depth of approximately 9000 mwe. It is found that the vertical intensity can be represented by the expression $I(0,h) = 9.8 \times 10^{-7} \exp(-h/\lambda)$ cm^{-2} sec^{-1} $sterad^{-1}$ where h is the depth in mwe and $\lambda = 810 \pm 50$ mwe. The corresponding angular distribution at vertical depth h is given by $I(\theta,h) = I(0,h) \sec\theta \exp[-(h/\lambda)(\sec\theta - 1)]$ where θ is

the zenith angle. The implication of this angular distribution for the estimate of neutrino fluxes in deep underground cosmic-ray experiments is discussed. (UK)

18474 EXPERIMENTAL TEST OF THE MECHANISM OF RADIO EMISSION FROM COSMIC-RAY SHOWERS. Porter, R. A.; Smith, F. G.; Torbitt, W. S. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.). Nature, 213: 1107(May 18, 1967).

It has been suggested that a detectable radio pulse should be emitted by an extensive air shower, based on the coherent emission from a negative charge excess in the shower front. It has also been shown that a radio pulse may be emitted by the transverse current in the shower front, resulting from separation of charges in the earth's magnetic field. Radiation resulting from separation of charges would be expected to dominate over that from an excess of charge. Radiation from the former would be polarised perpendicular to the earth's magnetic field, while radiation from the latter would be polarized radially from the shower center. Radio polarization studies are conflicting. A test of the relative importance of the effects of geomagnetic field and charge separation is to compare the magnitudes of pulses radiated by showers traveling along and perpendicular to the earth's magnetic field; such a test was made at Jodrell Bank. Details of the experimental setup are given, and data obtained are tabulated. It was found that radio pulses arriving across the lines of the geomagnetic field were not usually stronger than those arriving along these lines. It is concluded that the charge separation effects do not dominate. (UK)

18475 SPACE RADIATION DOSIMETRY. Madey, Richard (Clarkson Coll. of Tech., Potsdam, N. Y.). Health Phys., 13: 345-59(Apr. 1967).

Corpuscular radiations in space have been observed over an intensity range of about 27 orders of magnitude, and a kinetic energy span of about 17 orders of magnitude. The nature of space radiation problems depends on the number–energy distributions of the ionizing radiations encountered in space. Primary radiation sources consist principally of protons, alpha particles, and heavy nuclei in the cosmic radiation of solar and nonsolar origin, and protons and electrons in the geomagnetically trapped radiation. Secondary radiation sources arise from the interactions of the primary charged-particle radiation with matter. Problems in space radiation dosimetry are concerned with the proper assessment of the dose arising from charged-particle interactions with matter. Both the absorbed dose and the dose-equivalent often depend upon the nature of the degraded spectrum at the dose point. (auth)

18476 SEARCH FOR CHARGE-2/3 QUARKS PRODUCED BY COSMIC RAYS. Kasha, H. (Brookhaven National Lab., Upton, N. Y.); Leipuner, L. B.; Wangler, T. P.; Alspector, J.; Adair, R. K. Contract AT(30-2)-Gen-16. Phys. Rev., 154: 1263-4 (Feb. 25, 1967). (BNL-10677).

The flux of quarks with a charge equal to $\frac{2}{3}$ the charge of the electron which reach sea level from the vertical with relativistic velocities was measured to be less than 2.0×10^{-9} cm^{-2} sr^{-1} sec^{-1} at a 90% confidence level. Particles with fractional charge were identified through their characteristic energy loss in each of seven scintillation counters. (auth)

18477 COSMIC-RAY PARTICLES THAT CHANGED FROM 1954 TO 1958 TO 1965. Neher, H. V. (California Inst. of Tech., Pasadena). J. Geophys. Res., 72: 1527-39(Mar. 1, 1967).

During each of the two recent periods of special international coordination of scientific effort, the IGY (International Geophysical Year) and the IQSY (International Year of the Quiet Sun), a latitude survey was made of cosmic rays, using ionization chambers carried by balloons. All instruments were carefully compared with the same set of standards. In each case, simultaneous balloon flights were made from a high-latitude base station. Such monitoring of the primary radiation allowed corrections to be made to the data from the mobile station. Ratios of the abundances of the different nuclei to that of protons in the primaries as found by other observers were used to separate out the effect due only to protons. Two methods are used to find the differential spectrum of the protons for the different years. Above 1 BeV, the areas under successive latitude difference curves are used. This method takes advantage of the earth's magnetic field as an analyzer. Below about 0.6 BeV the ranges of protons in air and areas are used. The two methods give results that are consistent with each other. Where applicable the results are also in good agreement with the differential spectra of protons found by other observers using satellites and high-altitude balloons. From the integral of the differential spectra so derived for the different years, it is found that the total number of primary protons increased by a factor of 3.1 between 1958 and 1965. From similar flights made during the previous solar minimum the change from 1954 to 1958 is found to be a factor of 4.2. This, as well as solar activity data, indicates that there was more residual modulation of the primary cosmic radiation during the 1965 minimum than was present in 1954. (auth)

18478 COSMIC RAY STUDIES BY THE PROTON-1 AND PROTON-2 STATION SATELLITES. Grigorov, N. L.; Savenko, I. A.; Skurdin, G. A. Vestn. Akad. Nauk SSSR, No. 1, 21-8(Jan. 1967). (In Russian).

The space stations Proton-1 and Proton-2 were provided with a great variety of equipment for studying various aspects of cosmic radiation. Similar specialized devices were installed in both stations for investigating inelastic interaction cross sections of protons with carbon nuclei and for analyzing the particles on the basis of their charge, z, from protons with z = 1 to superheavy nuclei with z ≥ 50. The high-energy γ quantum flux and the high-energy electron flux and energy spectra could be measured up in the GeV range. Although the complete scientific instrumentation included 4100 transistors and 36 photomultipliers, both space stations operated with great reliability. In order to record directional data, the stations could be oriented as desired. The results showed that within the 3×10^{10} to 1.5×10^{14} eV range, the averaged integral spectrum of all particles may be approximated by the law $N(\geq E) = AE^{-\gamma}$, with an exponent value of $\gamma = 1.73 \pm 0.08$. Study of the energy spectra of the primary cosmic-ray particles revealed that in the 10^{10} to 10^{13} eV range, the spectra of proton and multiply charged particles are identical; at higher energies, the intensity of protons decreases at a faster rate with increasing energy, than the energy of all the particles. The energy spectrum of ultraheavy nuclei was measured near the equator and also at higher latitudes. The results indicated that the ratio of these ultraheavy particles and of helium nuclei is independent of the latitude of the place of measurement, indicating that the spectra of nuclei with z ≥ 42 and z ≥ 48 are similar to that of helium nuclei, at least in the 1 to 7 GeV/nucleon range. (TTT)

18479 RADIO PULSES FROM EXTENSIVE AIR SHOWERS. Allan, H. R.; Jones, J. K. (Imperial Coll. of Science and Tech., London). Nature, 212: 129-31(Oct. 8, 1966).

An experimental program is described which was set up to detect radio pulses in association with extensive air showers at the Joint Universities Air Shower Array at Haverah Park, near Harrogate, Yorkshire. In the measurements a 60-Mc amplifier with a linear detector connected to a horizontal aerial array of eight full-wave dipoles was used. The equipment was operated for a period of two months at a receiver bandwidth of 2 Mc, and in this period about 600 h of interference-free recordings was obtained. An analysis is presented on 28 radio pulses from a total of 625 recorded showers. (W.D.M.)

18480 ENERGY SPECTRUM AND GEOMAGNETIC CUT-OFF OF PRIMARY COSMIC-RAY α-PARTICLES NEAR 41°N MAG. Foster, F.; Schrautemeier, B. E. (Washington Univ., St. Louis). Nuovo Cimento (10), 47A: 189-94(Jan. 21, 1967). (TID-23031).

The energy spectrum of the primary cosmic α particles was measured using nuclear photographic emulsions flown from Alamogordo, New Mexico, on 14th May 1962. An emulsion-orienting mechanism allowed estimates to be made of the average geomagnetic cut-off energies in the east and west directions up to 45° zenith angle. Around the zenith, the cut-off was found to be (1.5 ± 0.1) GeV/nucleon kinetic energy, with a total flux of (80 ± 7) particles/m^2 s sr. The slope of the integral energy spectrum was found to be 1.7 ± 0.15 in the kinetic energy range from 2.5 to 10 GeV/nucleon. (auth)

18481 LI CONGRESSO NAZIONALE DELLA SOCIETA ITALIANA DI FISICA, BOLOGNA, 5–10 NOVEMBRE 1965. (Fifty-First Annual Meeting of the Italian Physical Society, Bologna, Nov. 5–10, 1965). Nuovo Cimento (1), 4: Suppl., 529-780(1966). (CONF-651153).

Separate abstracts are prepared for 8 of the 11 papers presented. (C.E.S.)

For abstracts of individual papers see: 17832, 17833, 18420, 18482, 18483, 18945, 18970, and 19103.

18482 PRESENT SITUATION IN THE STUDY OF ELECTRONS IN THE COSMIC RADIATION. Dilworth, C. (Univ., Milan). Nuovo Cimento (1), 4: Suppl., 665-73(1966).

Tabulated data on the estimates of secondary electron flux in the atmosphere, integral flux measurements, and differential flux measurements show the extensive revision of old data and the presentation of new data that has occurred in the last year. The uncertainty in the data on the sign ratio of electrons is indicated. The implication of the present experimental data is briefly considered. (J.S.R.)

18483 COSMIC RAYS AND SPACE RESEARCH. Scarsi, L. (Univ., Milan. Gruppo GIFCO del Consiglio Nazionale delle Ricerche, Milan). Nuovo Cimento (1), 4: Suppl., 725-55(1966).

Some recent results obtained in the investigation of cosmic

rays using space vehicles are illustrated. Information is included on the following: near space, interplanetary space, geomagnetic fields, interplanetary magnetic fields, corpuscular galactic radiation, solar energetic particles, x-ray astronomy, and γ-astronomy. (J.H.M.)

18484 ANISOTROPY OF GALACTIC COSMIC RADIATION. Baker, Paul Jr. Denver, Univ. of Denver, 1966. 61p. Thesis.

An experiment seeking evidence of a sidereal anisotropy in cosmic-ray-muon intensity is described. Data are taken with the Denver multidirectional double-coincidence muon telescope. It is oriented so as to have north, south, east, and west geometrical viewing directions, all inclined 37.3° to the zenith. Plastic scintillators are used to detect the muons. Each scintillator is 42 inches in diameter and 3 inches thick. A lead shielding layer of 6 inches thickness is interposed between each of the directional-array detectors. The average counting rate for each viewing direction is about 45,000 counts per hour. Sixty days of data, starting at 0 hours, Universal Time, on 18 May 1965, were initially processed. On a sidereal time base these data indicated an anisotropy in the south-minus-east curve. Six months later, a run of 84 days duration was made. Again, on a sidereal time base, the anisotropy was evident at the same location. This implied an effect of galactic origin since it persisted with sidereal time. Based upon these results, the following conclusions are made: first, it appears possible to detect a sidereal anisotropy in the muon-producing component without resorting to extensive analytic computation; second, there is strong evidence of the existence of a diminution, the magnitude of which is about 0.06%, in the intensity of galactic cosmic radiation in the vicinity of the celestial equator at approximately 3.5 hours right ascension. (Dissertation Abstr.)

Direct Energy Conversion

Refer also to abstract 17779.

18485 (AED-C-15-12) BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY. SECTION 15. DIRECT CONVERSION OF NUCLEAR ENERGY IN ELECTRIC ENERGY. Kalix, Erika (comp.) (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1967. 99p. (In Several Languages). Dep. mn.

A listing is given of approximately 330 papers dealing with all aspects of various direct energy conversion devices. An author index is included. (M.O.W.)

18486 (IPP-3/50) STROM- UND ELEKTROSTATISCHE POTENTIALVERTEILUNGEN IN MHD-GENERATOREN. (Current and Potential Distributions in MHD Generators). Lengyel, L. L. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1966. 22p. (In German). Dep. mn.

For the purpose of comparison with experimental measurements the following field distributions have been computed: the electrostatic potential and current distributions in Hall generators as functions of the axial potential drop (external load), electrode geometry, and the Hall parameter; and the electrostatic potential distribution in a Faraday generator of given geometry for two different values of the Hall parameter. Only the calculated field distributions are reported. (auth)

18487 (JPL-TR-32-970) FISSION-ELECTRIC CELL IRRADIATION. Krieve, Walter F. (Jet Propulsion Lab., Pasadena, Calif.). Mar. 1, 1967. Contract NAS7-100. 62p.

A series of capsule reactor irradiation experiments was performed to study the component behavior of fission–electric cell devices under relatively high-radiation intensity and with sufficient fuel burnup to establish operational trends. A detailed account of these experiments is given. Complete descriptions of the designs of the various fission–electric cell capsules, discussions of some of the specialized fabrication techniques, and a description of the experiments themselves are included. The experiments were concerned with electrical characteristics of the cells and with the materials problems associated with extended irradiation periods. In addition to the in-pile measurements of cell performance (as well as calibration runs in intense gamma fluxes), the experiments included extensive post-irradiation, microscopic, and radiochemical analyses. The rationale for the fission–electric cell program and the general conclusions of these experiments are reported elsewhere. (auth)

18488 (N-67-12903) SOLAR THERMIONIC GENERATOR DEVELOPMENT. Second Quarterly Report, March 1–June 1, 1966. (Thermo Electron Engineering Corp., Waltham, Mass.). June 1966. Contract NAS7-100. 28p. (NASA-CR-80200; TE-91-66). CFSTI $3.00 cy, $0.65 mn.

During the period, the second engineering model, T-202, was tested, and two unsuccessful attempts at the fabrication of the third, T-203, were made. Test results on T-202 indicated that the interelectrode spacing of converter T-202 is less uniform than that of converter T-201 and has a larger average value. Consequently, the performance of converter T-202 was lower in the unignited mode, and higher in the ignited mode than the performance of converter T-201. The attempts to fabricate T-203 failed because a more stringent revised outgassing procedure was applied in which the collector temperature during outgassing was brought up to 800°C rather than 700°C. The higher temperature appears to have caused the failure of the same braze in both instances. A new attempt is now in progress to fabricate T-203. (auth)

18489 (N-67-13216) THERMIONIC RESEARCH PROGRAM. Final Report, June 1965–June 1966. Kitrilakis, S.; Lieb, D.; Rufeh, F.; Van Someren, L. (Thermo Electron Engineering Corp., Waltham, Mass.). Aug. 1966. Contracts NAS7-100; JPL-951262. 264p. (NASA-CR-80525; TE-12-67). CFSTI $3.00 cy, $0.65 mn.

Results are presented from experimental research in thermionic energy conversion. Consideration is given to the use of CsF vapor in addition to metallic cesium in converters and to the effects of inert gases on converter characteristics. The test converter, associated equipment, and experimental techniques are discussed, and metallurgical data on the preparation and definition of the emitter surfaces employed are given. Filament-type metal ceramic tubes that were constructed to maintain, in operation, vacuums of the order of 10^{-10} torr are described, and results of parametric tasks conducted with an electroetched rhenium surface are related. An analysis of converter characteristics in the Boltzmann region is also included. (STAR)

18490 (NYO-3642-4) THE DEVELOPMENT OF AN ADSORPTION CESIUM RESERVOIR. Summary Technical Report. (Radio Corp. of America, Lancaster, Pa. Direct Energy Conversion Dept.). Dec. 1966. Contract AT(30-1)-3642. 86p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In developing a practical long-life thermionic converter with an adsorption-type cesium reservoir, work was directed towards the selection and evaluation of acceptable reservoir materials, reservoir design geometry, and the evaluation of adsorption reservoir performance. Adsorption reservoirs were integrated with operating thermionic converters in two series of performance tests. In the first series, adsorption reservoirs were positioned external to the converters; and in the other, the reservoirs were incorporated within the converter structures. Converters which were supplied cesium by adsorption reservoirs were subjected to life testing. Post-test analysis indicated that: (1) molybdenum matrix reservoirs can be saturated fully with cesium; (2) these reservoirs can be used in long life converters; (3) output power degradation after 700 hours was not attributable to the adsorption reservoir; and (4) the adsorption reservoir tends to compensate for small leaks and improves the reliability of converters. (J.H.M.)

18491 ELASTIC COLLISIONS IN SIMULATING ONE-DIMENSIONAL PLASMA DIODES ON THE COMPUTER. Burger, Peter (Stanford Univ., Calif.). Phys. Fluids, 10: 658-66(Mar. 1967).

The inclusion of electron–neutral collisions in computer-simulation calculations is demonstrated. Only one-dimensional fields are considered in diodes with plane–parallel symmetry. The method used is to change the velocities of particles in a random manner according to their probabilities of suffering a collision. The method is applied to the hard-sphere type of collisions between electrons and neutrals. Three examples are shown, and in two of them comparison between analytical and computer-simulation results are possible. Reasonably good agreements are obtained. It is demonstrated that the inclusion of electron–neutral collisions into computer simulation procedures could be used for finding the damping effect of these collisions on the oscillatory behavior of unstable plasma diodes. With this method we can compute the large-signal, time-dependent characteristics of diodes at intermediate pressures in which the mean-free path is comparable to the diode distance. (auth)

18492 SPECTROSCOPIC MEASUREMENTS OF THE PLASMA PARAMETERS OF A THERMIONIC CONVERTER. Kaplan, V. B.; Moizhes, B. Ya.; Pikus, G. E.; Shakhnazarova, G. A.; Yur'ev, V. G. (Inst. of Semiconductors, Leningrad). Zh. Tekh. Fiz., 36: 1901-4(Oct. 1966). (In Russian).

The plasma parameters (concentration, electron temperature, proportion of excited atoms, etc.) in an arc-mode thermionic converter were optically determined by means of a mirror monochromator with photoelectric registration and potentiometric

recording. Care was taken to exclude from the treatment the long-wave lines of the P-D and F-D transitions, which showed significant adsorption, and to eliminate the cathode illumination while the measurements of the continuum intensity were being taken. The investigations were made at cathode temperatures from 1100 to 1600K and at cesium vapor pressures from 0.4 to 2.0 mm hg. The interelectrode distances varied from 1 to 2.0 mm. The investigation demonstrated that the electron temperature decreases monotonically between the cathode and anode. The maximum of the electron concentration was found at a distance of 0.3 mm from the cathode. It was also found that the distribution of the excited atom concentration does not follow the changes of the electron temperature. The transition from generation to recombination takes place close to the point at which the temperature and line intensity curves intersect. If it is assumed that at this point neither generation nor recombination occurs, then the concentration of electrons and excited atoms at this point should be close to the thermodynamic equilibrium. At T_e = 2500K, the thermodynamic concentration should be 1.25×10^{14} cm^{-3} (the measured concentration was 7×10^{13} cm^{-3}). (ATD)

18493 LOW-VOLTAGE ARC MODE IN THERMIONIC CONVERTERS. Popescu, Iovitzu; Popescu, Denisa (Inst. of Physics, Bucharest). Rev. Roum. Phys., 11: 725-45(1966).

A diffusion theory, including thermodiffusion, is correlated with recent experimental data on the low-voltage arc in cesium vapors. Quantitative interpretations are given for spectrographic, solid-probe, and output characteristics measurements, which appear particularly useful in the development of practical high-pressure thermionic energy converters. (auth)

18494 ERTEZA CHANNEL MHD GENERATOR. Rao, Kamisetty Ramamohan. Albuquerque, N. Mex., Univ. of New Mexico, 1966. 94p.

Thesis.

An MHD generator with a novel configuration (proposed by Dr. Ahmed Erteza, Univ. of New Mexico) is analyzed for power generation. The generator consists of two coaxial cylinders with a smooth annular space between them. Pressure-driven ionized gas flows axially through this annular space. Both the inner and outer cylinders have built into them magnetic poles and electrodes separated by insulators. These are periodically distributed, and the entire assembly offers a smooth cylindrical surface to the fluid flow. The generator resembles a multipole d-c machine, and is essentially a series-parallel combination of several usual rectangular channels. Starting with Maxwell's and hydrodynamic equations, a one-dimensional steady state analysis of the generator is carried out. Expressions for electromagnetic fields, current density, pressure gradient and electric potential are obtained in the form of rapidly converging infinite series. From these results, total radial (load) current internal impedance and conversion efficiency of the Erteza channel are evaluated. Considering the electrode width and the radii of the two coaxial cylinders to be variables, generalized expressions relating to the generator performance are obtained. From this, the influence of the electrode width and the influence of the radii of inner and outer cylinders on the internal impedance and on the efficiency of the MHD generator is found. It is shown that the internal impedance initially decreases at a rapid rate with the increase of electrode width ($\theta_e = 4\pi/3P$). Thereafter the internal impedance approaches an asymptotic value. The generator efficiency, likewise, increases with the electrode width θ_e, reaching an optimum value near $\theta_e = 4\pi/3P$. Further increase in electrode width actually results in a decrease in efficiency. The performance characteristics of the Erteza-channel MHD generator are compared with those of a MHD generator possessing rectangular geometry. Keeping the cross sectional area of the rectangular duct the same as that of the Erteza channel, the width-to-height ratio of the former is varied from one to six in steps of one. Comparison of the two characteristics shows that the cylindrical geometry offers a better efficiency compared to the rectangular channel, provided $r_0/r_i \leq 4$, and the electrode width $\theta_e = 4\pi/3P$. For $r_0/r_i > 4$, the rectangular geometry, has, by far, improved efficiency over that of the coaxial channel. In conclusion, for direct energy conversion by magnetohydrodynamic principles, the feasibility of the Erteza channel is demonstrated. (Dissertation Abstr.)

18495 ELECTRODE FOR MAGNETOHYDRODYNAMIC DEVICES. (to Avco Corp.). British Patent 1,059,767. Feb. 22, 1967. Priority date May 14, 1963, United States.

A description is given of an electrode for magnetohydrodynamic generators that includes an elongated and narrow electrically conductive metallic member having at least one recess extending substantially the length of the electrode on one surface, and a heat-resistant filler in the recess exposed to the conductive fluid. The filler is electrically conductive at the operating temperature of the fluid and an insulator at a temperature substantially less than the operating temperature of the fluid. (J.H.M.)

18496 OPTIMIZED FIGURE OF MERIT FOR A PLASMA THERMOCOUPLE. Kenyon, Richard Albert. Syracuse, N. Y., Syracuse Univ., 1965. 193p.

Thesis.

The figure-of-merit concept has proven to be an extremely valuable one in the prediction of the performance characteristics of the semi-conductor thermoelectric engines for direct conversion of heat to electric power. The figure of merit provides a single, temperature-dependent, material parameter that can be utilized to compare prospective thermoelectric materials and to predict the theoretical efficiencies of proposed direct conversion devices. For the semiconductor device, the figure of merit is a function of the Seebeck coefficient, thermal conductivity, and electrical resistivity of the thermoelement materials and it represents essentially a ratio of the applied energy converted to useful power to the energy lost due to thermal conduction and Joule heating. Several authors have attempted, with varying degrees of success, to apply the figure-of-merit concept to the thermionic diode used as a direct conversion device. This work develops the figure of merit concept along the same lines as those employed by Hatsopoulus for the strictly high vacuum case, but includes the effects of thermal conductance in the plasma. The resulting figure of merit is limited to operation over differential temperature and voltage gradients, and to a medium pressure range defined for cesium vapor as 10^{-4} to $1-^{-1}$ torr. (Dissertation Abstr.)

Fluid Physics

Refer also to abstracts 18616, 18660, and 18846.

18497 (N-66-37643) MIXING AND HEAT TRANSFER OF AN ARGON ARCJET WITH A COAXIAL FLOW OF COLD HELIUM. Final Report. Grey, Jerry; Williams, Peter M.; Fradkin, David B. (Princeton Univ., N. J. Guggenheim Labs. for the Aerospace Propulsion Sciences). Oct. 30, 1964. Contract NAS3-3680. 66p. (NASA-CR-54432). CFSTI $3.00 cy, $0.65 mn.

The mixing of a subsonic, 1-cm-diam, argon arc jet with a coaxial flow of cold helium in a 3-in-diam duct was studied visually by Schlieren photography and quantitatively with a calorimetric and sampling probe. Measurements of temperature, velocity, and composition of the mixing field were made for an initially laminar argon jet; the effects of cold coaxial helium on jet mixing characteristics were studied; and the effect on the flow field of varying the argon jet flow was investigated. The experimental apparatus is discussed in detail and diagrammed, including the plasma generator, duct and test section, Schlieren system, and calorimetric probe. Results indicated potential feasibility of the coaxial gaseous-core nuclear rocket. The observed mechanism of jet cooling and mixing was considered consistent with the requirements for retention of gaseous nuclear fuel. (STAR)

18498 (N-67-12924) CONTINUUM ELECTROMECHANICS GROUP: TRAVELING WAVE BULK ELECTROCONVECTION INDUCED ACROSS A TEMPERATURE GRADIENT. Melcher, J. R.; Firebaugh, M. S. (Massachusetts Inst. of Tech., Cambridge. Center for Space Research). Oct. 28, 1966. 33p. (NASA-CR-80101; CSR-TR-66-13). CFSTI $3.00 cy, $0.65 mn.

If a temperature gradient is imposed on a slightly conducting liquid, a gradient in natural electrical conductivity generally results. It is shown that if the liquid is then subjected to a wave of electric field traveling perpendicular to the temperature and conductivity gradients, charges are induced in the liquid bulk. These charges relax to form a traveling wave which interacts with the imposed field to pump the liquid. The sign of the conductivity gradient determines whether the liquid is pumped in the same direction or a direction opposite to that of the traveling wave. Equations are given for the velocity profile in plane flow, showing the effect of fluid properties as well as of the frequency, wavelength, and potential of the traveling wave. Experiments support the significance of the theory. Observations of a type of bulk Rayleigh–Taylor instability are discussed. (auth)

18499 CERTAIN PRECISE SOLUTIONS FOR STATIONARY GAS FLOW IN A PERPENDICULAR MAGNETIC FIELD. Mallik, D. D. Izv. Akad. Nauk SSSR, Mekh. Zhidkosti Gaza, No. 1, 9-13 (Jan.-Feb. 1967). (In Russian).

It is shown that this problem can be reduced to that of determining the unknown function, χ, satisfying the differential equation in particular derivatives. Since the equation for χ is very complex, only two cases are examined: (1) when the flow is steady, and (2) when the pressure is constant along the line of flow. (tr-auth)

18500 SOLUTION FOR A VARIABLE PROBLEM ON FLOW IN A MHD GENERATOR. Kovbasyuk, V. I.; Medin, S. A. Izv. Akad. Nauk SSSR, Mekh. Zhidkosti Gaza, No. 1, 3-8(Jan.-Feb. 1967). (In Russian).

The solution of problems on the flow of plasmas with variable conductivity in MHD generators, having the maximum output at an assigned length or capacity of the channel, is reported. The solution is analyzed and the extreme flow compared with the optimized flow in generators with constant electric parameters and Mach flow number. (tr-auth)

18501 THE CONVECTIVE FLOW OF AN MHD FLUID BETWEEN TWO OSCILLATING FLAT PLATES. Sluyter, Marshall Maxwell. Chicago, Illinois Inst. of Tech., 1965. 92p. Thesis.

An analysis is made of the buoyant motion of an incompressible and electrically conducting fluid, contained between parallel vertical walls, when subjected to a steady oscillation of its boundaries. It is assumed that the fluid and the boundaries have finite and constant electrical and thermal properties. Viscous dissipation and Joulean heating are included through the appropriate terms in the energy equation. The geometrical configuration of the flow consists of two infinite vertical flat plates separated by a finite distance and oscillating in their own plane with constant amplitude and frequency. A constant and uniform magnetic field is applied transversely to the plates which are maintained at constant temperature. It is seen that the equations describing the motion are decoupled, the axial motion being solved independently of the convective motion. Furthermore, the axial motion equations are linear. The convective motion equations, which also include the effect of an oscillating pressure gradient, are linearized through an expansion in powers of small Grashof number. It is assumed that the volumetric coefficient of expansion and the temperature range is sufficiently small. For the axial motion three dimensionless parameters are significant: magnetic Reynolds number, viscous Reynolds number, and the magnetic pressure number. It is found that increasing the conductivity of the boundaries will result in an increase of the amplitudes of the velocity, the magnetic field and the mass flow. Moreover, comparison with the purely viscous flow shows that, regardless of the conductivity of the boundaries, the magnetic field increases the velocity amplitude. Higher magnetic pressure number will also increase the amplitude. In either situation, the increase is more significant near the center of the channel for the velocity amplitude and near the walls for the magnetic field. It is observed that the presence of the magnetic field results in a retardation of the velocity. The temperature profile across the channel increases with the magnetic pressure number while the convective velocity is reduced. It is shown also that the effect of high wall conductivity is very close to that of wall of infinite conductivity. The investigation also includes a study for limiting values of the significant parameters. (Dissertation Abstr.)

Geophysics

Refer also to abstracts 18366, 18687, 18767, and 18774.

18502 (AD-642729) ROCKET INSTRUMENTATION FOR AURORAL MEASUREMENTS: NIROS AD 7.618D AND AD 7.619D. Burt, D. A.; Seljaas, K. G. (Utah Univ., Salt Lake City. Upper Air Research Lab.). Oct. 1966. Contract AF 19(628)-4995. 122p. (AFCRL-66-738). CFSTI $3.00 cy, $0.65 mn.

Information is presented on instrumentation developed for use in two Nike iriquous (Niros) rockets AE 7.618D and AE 7.619D designed for auroral measurements and flown in 1965 at Fort Wainwright, Alaska, by Air Force Cambridge Research Laboratories. The two rockets were identical and carried instruments designed to measure the following: electron energy spectrum from 2.5 to 100 keV; energy deposition (electrons E > 8 keV and protons E > 100 keV); auroral light, 3914 A; auroral light wideband (4000–1200 A); electron density; Bremsstrahlung X rays (1–8 A); electron temperature; electron energy spectrum from 25 eV to 5 keV (auth)

18503 (N-66-24115) THERMAL BEHAVIOR OF THE IONOSPHERE AND OBSERVATIONS OF THE EXOSPHERE AND THE IONOSPHERE BY MEANS OF DISTANT EARTH SATELLITES. Technical Report No. 2. da Rosa, A. V. (Stanford Univ., Calif. Stanford Electronics Labs.). Dec. 1965. Contract NASr-136. 133p. (NASA-CR-74227; SEL-65-109). CFSTI $3.00 cy, $0.65 mn.

A theoretical study of the time dependent thermal behavior of the ionospheric electron gas was made. The conclusions from this study are discussed and evaluated. The results from the radio beacon experiment aboard the Eccentric Geophysical Observatory (EGO) satellite are also treated. Profiles of local electron concentration in the exosphere at heights between 6000 and 30,000 km were obtained. In addition, the examination of early morning data showed rearrangements in the ionized layer taking place between one half and one and one half hours after sunrise. An interpretation of this rearrangement is provided. A statistical investigation of the behavior of the nighttime columnar content of the ionosphere was also conducted. This investigation is based upon data obtained from Faraday rotation angle measurements using the 136 Mc telemetry carrier of the Syncom III satellite. The results of this investigation are analyzed. (STAR)

18504 (N-66-24953) LUNAR RADAR MEASUREMENTS OF THE DIURNAL EXCHANGE OF IONIZATION BETWEEN THE IONOSPHERE AND THE MAGNETOSPHERE. Scientific Report No. 14. Yoh, Philip (Stanford Univ., Calif. Stanford Electronics Labs.). Dec. 1965. 27p. (NASA-CR-74781; SEL-65-103). CFSTI $3.00 cy, $0.65 mn.

During the period from December, 1963, to April, 1964, a large number of simultaneous measurements of the Faraday polarization rotation and the Doppler excess frequency of radar echoes were made at Stanford, California. The experimental results showed a large temporal variation of the electron content above the earth's ionosphere. This variation of the electron content is attributed to an exchange of ionization between the ionosphere and the lower magnetosphere. A net upward electron flux of about 3.7×10^{12} m^{-2} sec^{-1} is found in the morning; the corresponding number for downward flow in the afternoon is about 2.8×10^{12} m^{-2} sec^{-1}. If a diffusive-equilibrium model is assumed, it can be demonstrated that the cause of this flow is the change of temperature in the region of the upper ionosphere and lower magnetosphere. (auth)

18505 (N-67-13130) STATISTICAL MECHANICS OF CHARGED PARTICLES IN THE PRESSURE OF MAGNETIC IRREGULARITIES. Fibich, M.; Sandri, G. (Yeshiva Univ., New York. Belfer Graduate School of Science). Mar. 1966. Contract NAS5-9159. 30p. (NASA-CR-80483; ARAP-82). CFSTI $3.00 cy, $0.65 mn.

A model is introduced to describe the interaction of cosmic rays (either of solar or of galactic origin) with the solar wind. The model consists in replacing the magnetic irregularities in the wind by highly localized scattering centers. The statistical mechanical theory corresponding to this model is traced in detail from Liouville's theorem through a kinetic equation to the conventional diffusion equation. The statistical nature of the fields within the magnetic irregularities is described in terms of an appropriate Fourier analysis. (auth)

18506 (N-67-13163) PROPOSAL FOR TRAPPED PARTICLE FLUX MAPPING IN THE OUTER MAGNETOSPHERE. Roederer, Juan G. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1966. 35p. (NASA-CR-55615; X-640-66-313). CFSTI $3.00 cy, $0.65 mn.

A computer code is described which can be used for a two-dimensional mapping of directional fluxes of energetic particles trapped in the outer magnetosphere. G. Mead's model of the magnetospheric field is used. The main function of the code is to find, on a fixed reference meridian, the field line, equatorial pitch angle and other parameters of the shell generated by the particles in their longitudinal drift, provided they are stably trapped. A series of curves is given, which can be used for a first rough, graphical attempt of flux mapping. The code is described in detail in the appendix. (auth)

18507 (NASA-SP-3038) ELECTRON DENSITIES AND SCALE HEIGHTS IN THE TOPSIDE IONOSPHERE: ALOUETTE I OBSERVATIONS RECORDED AT HAWAII, WINTER 1962–1963, SUMMER 1963. Colin, Lawrence; Chan, Kwok-Long (National Aeronautics and Space Administration, Moffett Field, Calif. Ames Research Center). 1967. 284p. CFSTI $3.00 cy, $0.65 mn.

Data are presented on electron density and plasma scale height at various heights and times in the topside ionosphere. Electron densities (in units of 10^5 electrons per cm^3) and plasma scale heights (in units of km) are tabulated with values given in altitude increments of 50 km. Three types of graphs are presented: (1) electron density at seven fixed altitudes (400, 500, 600, 700, 800, 900, and 1000 km) and scale height at three fixed altitudes (500, 700, and 900 km) versus dip latitude for each of the Alouette I passes analyzed, (2) average winter and summer electron density and scale height at these altitude versus dip latitude for 1-hour local time increments, and (3) average winter and summer electron density and scale height at these altitudes versus local time for 5° dip latitude increments. (J.H.M.)

18508 WAVES IN A PARTIALLY IONIZED PARAMAGNETIC GAS. Hodges, R. R. Jr. (Southwest Center for Advanced Studies, Dallas). Radio Sci., 2: 311-18(Mar. 1967).

The nature of electromagnetic wave propagation in a partially ionized paramagnetic gas in a static magnetic field is explored. It is necessary to characterize such a medium by second-order

tensor expressions for both the permittivity and permeability, the former being that characteristic of an ordinary magnetoplasma, and the latter that for a magnetized paramagnetic medium. Employing linearized forms of these and Maxwell's equations leads to a general dispersion relation. For lossless conditions it is shown that the resonances and cutoffs associated with the free electrons and those due to the paramagnetic constituents are independent. This leads to some interesting, hypothetical propagation conditions that may exist in planetary or stellar atmospheres. Application of this theory is made to the ionosphere, in which atomic oxygen is the major paramagnetic constituent. Accounting for collisional losses, it is shown that the upper limit of the absorption at the peak of the atomic oxygen electron spin resonance line in the ionosphere is only 5×10^{-4} times the background absorption due to the free electrons: the effect of Doppler broadening would be to decrease this number. The minute nature of this absorption line is supported by the apparently complete lack of experimental evidence of electron spin resonance effects on radio wave propagation in the terrestrial ionosphere. It is also shown that the internal radiation (noise) in the ionosphere must exhibit a similarly weak absorption line at the electron spin resonance, due to the nonequilibrium nature of the energy distribution of the free electrons. (auth)

18509 RECENT CHANGES IN THE MAGNETIC DIPOLE MOMENT OF THE EARTH. Leaton, B. R.; Malin, S. R. C. (Royal Greenwich Observatory, Hailsham, Eng.). Nature, 213: 1110 (Mar. 18, 1967).

In the course of an investigation into magnetic secular variation a number of spherical harmonic analyses were performed on successive 5-year means of results from 80 magnetic observatories and, from the first three coefficients, the moment of the equivalent dipole of the geomagnetic field was deduced in terms of the earth's radius. Results are tabulated and indicate that the dipole moment continues to decrease; they suggest an increasing rate of decrease. It is stated that it is tempting to suggest an eventual field reversal, within the next few thousand years. (UK)

18510 IONOSPHERIC STATE ACCORDING TO OBSERVATION RESULTS OF ELECTRON 1 AND ELECTRON 3. Mityakova, E. E.; Cherepovitskii, V. A. (Gorkii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 7-13(1967). (In Russian).

The observation results are given of phase difference of the signals with coherent frequencies of 20 and 30 Mc from Sputniks Electron 1 and Electron 3 during February–March and July–October 1964. The daily variation of the total electron concentration $N_n\infty = \int_0^\infty Ndz$ is obtained. The minimal values of $N_n\infty$ (0.2–0.3) 10^{13} e/cm^{-2} are observed in the nighttime, the maximal values $N_n\infty$ (1.3 to 1.5) 10^{13} e/cm^{-2} in the hours after the noon. The dependence is given of the effective ionosphere thickness upon the daytime. These observed two maxima of the effective ionosphere thickness in the period of the sunrise and the sunset. Variations of sizes of large-scale inhomogeneities and relative changes of electron concentration $\Delta N_n/N_n$ are obtained as functions of daytime and latitude. (auth)

18511 THE EFFECTS OF PARTICLE RADIATION FROM A DISTURBED SUN ON ATMOSPHERIC ELECTRICITY. Pakiam, J. E.; Johnson, D. W. (Univ. of Saskatchewan, Saskatoon). Can. J. Phys., 45: 1337-51(Mar. 1967).

It is shown, from a consideration of atmospheric-electric theory and of the radiation emitted from a disturbed Sun, that the corpuscular solar radiation has little effect on atmospheric-electric conditions at ground level. Though the aurora and associated bremsstrahlung ionization should have little or no effect at ground level, several observers have found some correlation. For this reason, experimental measurements of potential gradient and air conductivity were taken at Saskatoon and at Churchill to investigate any apparent relationship between the aurora and atmospheric electricity. Statistical analysis revealed no definite relationship between aurorae and potential gradients or air–earth current densities over the period of a night. Large fluctuations in potential gradient (and often of air conductivity) were encountered at night, sometimes even coincident with the occurrence of aurorae. However, these fluctuations were considered to be due to the formation of space-charge packets due to low wind speeds. (auth)

18512 ARCHAEOMAGNETIC AND PALAEOMAGNETIC STUDY OF THE MAGNETIC FIELD OF THE EARTH IN THE PAST 600,000 YEARS. Bucha, V. Nature, 213: 1005-7(Mar. 11, 1967).

Direct observations provide information concerning variation of the Earth's magnetic field only during the past 400 years, but these records can be considerably extended by archaeomagnetic and palaeomagnetic investigations. This note reports new information based on data gathered from the following sources: (1) measurements of the thermoremanent magnetism of baked clay samples, which provide information concerning the past 6,800 years, (2) measurement of magnetic declination and dip on loess samples from a defile of layers in South Moravia, 18m thick, and (3) investigation of the magnetization of baked clays and porcelanites produced by underground combustion of Tertiary coal deposits in North Bohemia, which have acquired high thermoremanent magnetization during the Quaternary period (last 600,000 years). (UK)

18513 SOLAR WIND PROPERTIES OBTAINED FROM THE STUDY OF THE 11-YEAR COSMIC-RAY CYCLE. I. Dorman, I. V.; Dorman, L. E. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). J. Geophys. Res., 72: 1513-20(Mar. 1, 1967).

On the basis of investigations of the 11-year cosmic-ray cycle, the dimensions of the region filled with the solar wind, the scattering transport paths of particles of various energies, and the change in spectrum of magnetic inhomogeneities with respect to solar activity are studied. Using comparatively high-energy cosmic rays and taking account of the time lag of interplanetary space conditions relative to processes on the sun, these properties of the solar wind and others, such as the true cosmic-ray intensity beyond the region filled with the solar wind, are evaluated. (auth)

18514 LOW-ALTITUDE TRAPPED ELECTRON BOUNDARY COLLAPSE DURING MAGNETIC STORMS. Williams, Donald J. (Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 1644-6(Mar. 1, 1967).

Evidence is presented supporting the argument that high-latitude field lines are extended out into the geomagnetic tail to the point of not being able to support a stably trapped population. The data were obtained from instruments aboard the satellite 1963 38C, a magnetically oriented satellite in a very nearly circular polar orbit at an altitude of 1100 km. A solid-state detector capable of monitoring trapped electrons of energy greater than 280 keV was employed. During the time of observations, April 17 through 19, 1965, the orbital plane of 1963 38C was 13° ± 2° from the noon-midnight meridian. The data concern the magnetic storm that occurred on April 18, 1965. (J.H.M.)

18515 POTENTIAL BUILDUP ON AN ELECTRON-EMITTING IONOSPHERIC SATELLITE. Parker, Lee W.; Murphy, Brian L. (Mt. Auburn Research Associates, Inc., Cambridge, Mass.). J. Geophys. Res., 72: 1631-6(Mar. 1, 1967).

An experiment in which a continuous beam of high-energy electrons is emitted from a satellite (e.g. to produce an artificial aurora or to map the geomagnetic field) will be jeopardized if the satellite potential becomes so high that the beam electrons cannot escape. The potential acquired by the satellite is determined by the condition that it collects from the ambient ionosphere a current equal to the emitted current. The geomagnetic field severely limits the current that may be emitted. For example, a spherical satellite of radius 1.5 m in the F layer cannot emit more than about 40 mA of kilovolt electrons. (auth)

18516 VERY-LOW-FREQUENCY RADIO EMISSION FROM THE UPPER ATMOSPHERE AND ITS CONNECTION WITH OTHER GEOPHYSICAL PHENOMENA. Gershman, B. N.; Trakhtengerts, V. Yu. (Gorkii State Univ., USSR). Usp. Fiz. Nauk, 89: 201-25(June 1966). (In Russian).

This is a review, with emphasis on the results obtained since 1960, of the information concerning the state of the exosphere which can be extracted from radio signals of variable frequency between 1 and 20 kcs (whistlers), especially the radio waves generated in the exosphere directly. The most essential results of recent years, obtained by reduction and analysis of whistler observations, are first reviewed. The different types of vlf radiation (hiss, chorus, and discrete radiation) are described and the results of systematic observations obtained with land based equipment and satellites are presented. This is followed by problems involved in the generation of different types of whistlers and an analysis of the significance of vlf noise in the dynamics of the earth's outer radiation belt, and the role of vlf radiation in the dynamics of the earth's radiation belts. It is concluded that the recent experimental results can throw light on the origin of different types of vlf radiation, and that there are important grounds for assuming that this radiation is produced by high-energy particles in the earth's outer radiation belt and in the aurora zones. There are also reasons for assuming that the vlf radiation plays an important role in the dynamics of the earth's radiation belts. Several problems whose solutions will contribute to clarification of the nature of vlf radiation are listed. (ATD)

18517 POLARITY PATTERN OF THE INTERPLANETARY MAGNETIC FIELD DURING SOLAR ROTATIONS 1798 TO 1808. Coleman, Paul J. Jr. (Univ. of California, Los Angeles); Davis,

Leverett Jr.; Smith, Edward J.; Jones, Douglas E. J. Geophys. Res., 72: 1637-43(Mar. 1, 1967).

Polarity patterns observed in the interplanetary magnetic field during the period in which the tracking of Mariner 4 was relatively continuous are described. The period extended from November 28, 1964 to October 1, 1965, and included more than 10 periods of solar rotation. (J.H.M.)

18518 RADIO FREQUENCY SYNCHROTRON RADIATION FROM THE VAN ALLEN BELTS. Vesecky, J. F.; Peterson, A. M. (Stanford Univ., Calif.). J. Geophys. Res., 72: 1647-50 (Mar. 1, 1967).

Consideration is given to the observation of radio frequency synchrotron emission from Van Allen electrons. Discussions and calculations are included on how radio brightness varies with the direction and frequency of observation. An estimate is made assuming that the electrons in the radiation belts radiate in the synchrotron mode. A view perpendicular to the geomagnetic equatorial plane is shown that illustrates some of the ray paths for which brightness estimates are made. Propagation conditions in the magnetoionic medium along the ray paths are taken into account. (J.H.M.)

18519 LABORATORY RATE COEFFICIENTS FOR POSITIVE ION–NEUTRAL REACTIONS IN THE IONOSPHERE. Warneck, Peter (GCA Corp., Bedford, Mass.). J. Geophys. Res., 72: 1651-3(Mar. 1, 1967).

Until recently, the relative importance of many reactions in the ionosphere could not be assessed because a detailed knowledge of the individual thermal rate coefficients was either lacking or rather uncertain. Efforts in several laboratories have resulted in the experimental determination of many of the required rate constant values. A comparison is presented of the various laboratory results to show that they have improved to the point where a reasonable consistency has been achieved, thereby providing a set of acceptable thermal rate constant values for future ionospheric studies. (J.H.M.)

18520 INHERENT LIMITATION OF THE WAVE INTERACTION EXPERIMENT. Manson, Alan H. (Univ. of Saskatchewan, Saskatoon). J. Geophys. Res., 72: 1654-6(Mar. 1, 1967).

Results are presented of an experimental study of the wave interaction technique for measuring electron number densities. (J.H.M.)

18521 NEGATIVE IONS IN THE NIGHT IONOSPHERE AND THE CONTINUOUS SUB-ELF EMISSIONS. D'Angelo, N. (Atomic Energy Commission Research Establishment, Risoe, Denmark). J. Geophys. Res., 72: 1541-6(Mar. 1, 1967).

A possible association of the nocturnal sub-ELF emissions, observed by Tepley and Amundsen, with high percentages of negative ions in the night ionosphere is discussed. Calculations show that very modest electron drifts are sufficient to excite ion-acoustic oscillations in a plasma with large percentages of negative ions. Ion-acoustic oscillations in the night ionosphere would produce oscillations in the earth's magnetic field records, very similar to those observed by Tepley and Amundsen. (auth)

18522 ATTENUATION OF GALACTIC RADIO NOISE AT 25 Mhz AND 21.3 Mhz IN THE IONOSPHERE OVER AHMEDABAD DURING 1957–1964. Abdu, M. A.; Degaonkar, S. S.; Ramanathan, K. R. (Physical Research Lab., Ahmedabad, India). J. Geophys. Res., 72: 1547-54(Mar. 1, 1967).

Measurement of the intensity of galactic radio noise at Ahmedabad from 1957 to 1964 has shown that its attenuation has decreased steadily with the decline of solar activity. Calculation of the absorption in the D region and in the F region up to the F_2 peak using N(h) profiles and effective collision frequencies of electrons has shown that a large part of the absorption of galactic radio noise takes place in the F region over Ahmedabad, both below and above the F_2 peak. It is also found that the nighttime attenuation in low solar activity period (1964–1965) is much larger than can be explained on the basis of electron-ion collision processes alone. It is suggested that scattering of galactic radio noise by inhomogeneities in the F region is a source of extra attenuation during night in a low solar activity period, since it is known that the occurrence of spread F shows a considerable increase during night at Ahmedabad in low sunspot years. The absorption measurements also suggest that electron temperatures are appreciably higher than neutral gas temperatures in the early morning hours and that the excess temperature of electrons is higher in low sunspot years than in high sunspot years. (auth)

18523 NIGHTTIME F2 LAYER AT THE EQUATOR. Varnasavang, V. (London Univ.). J. Geophys. Res., 72: 1555-61 (Mar. 1, 1967).

The behavior of the nighttime equatorial F_2 layer under the influence of ambipolar diffusion and an electrodynamic drift was studied theoretically. It is shown that there exists a maximum in the nighttime variation of the electron number density at constant height and that this maximum depends mainly on the nature of an electrodynamic drift. The effect due to ambipolar diffusion is comparatively small, and the rate of decay of ionization is affected to an appreciable degree by an increase in the magnitude of the drift. The results indicate that, apart from the thermal contraction of the atmosphere, an electromagnetic drift may be an important factor in the formation of the maxima observed in electron profiles at a constant height. (auth)

18524 THE APPARENT MOVEMENT OF THE SPECTRAL COMPONENTS IN FADING RECORDS OF IONOSPHERICALLY REFLECTED RADIO WAVES. Gossard, Earl E. (Navy Electronics Lab., San Diego, Calif.). J. Geophys. Res., 72: 1563-9 (Mar. 1, 1967).

An experiment designed to measure ionospheric movements near 90 km using very low radio frequencies is described. Cross spectrum analysis between fading records obtained at three receivers on the ground forming a triangle is used to obtain the apparent movement of the various frequency components in the fading records. It is found that the fading records are often dominated by "beating" between the on-path reflected signal and one or two off-path wave components. This Doppler interference fading is not simply related to ionospheric movements, and it often contaminates the cross correlograms to such an extent that they have little meaning. It is suggested that similar Doppler interference from off-vertical reflectors may account for some of the paradoxical results that have been obtained in high-frequency drift measurements. When the Doppler spectral components are avoided, a consistent pattern of movement versus fading frequency appears. The results imply that drift alone cannot explain the fading patterns and are not inconsistent with a regime in which both drift and internal wave motion are present. (auth)

18525 RELATIVE IMPORTANCE OF SOLAR RADIATION AND GRAVITATIONAL TIDE IN CAUSING GEOMAGNETIC VARIATIONS. Gupta, Jagdish C. (Univ. of California, Los Angeles). J. Geophys. Res., 72: 1583-90(Mar. 1, 1967).

For an assumed model of the ionosphere, partial coherence functions were computed to investigate the contribution of solar radiation and of gravitational tide in causing geomagnetic variations (and hence the tides in the ionosphere). It is found that (1) at the diurnal frequency solar radiation contributes about 99% to geomagnetic variation, the gravitational contribution being negligible, and (2) at the semidiurnal frequency solar radiation and gravitational tide contribute nearly 90 and 10%, respectively, to geomagnetic variations. (auth)

18526 GEOMAGNETIC PERTURBATIONS AND UPPER-ATMOSPHERE HEATING. Jacchia, L. G. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Slowey, J.; Verniani, F. J. Geophys. Res., 72: 1423-34(Mar. 1, 1967).

The density variations that accompany geomagnetic disturbances were studied by analyzing the drag of three satellites with high orbital inclination (Injun 3, Explorer 19, and Explorer 24) and one with moderate inclination (Explorer 17). The average time delay between the peak of the geomagnetic perturbation and that of the atmosphere is 6.7 ± 0.3 hours. While there seems to be no significant dependence of the time delay on the intensity of the perturbation and on the geographic location with respect to the sun, there appears to be some dependence on latitude. For latitudes greater than 55° (average: 65°) the mean time delay is 5.8 ± 0.5 hours, and for latitudes smaller than 55° (average: 25°) it is 7.2 ± 0.3 hours. All three high-inclination satellites give consistently smaller delay times at high latitudes. The observed density changes are interpreted as being caused by changes in temperature. For smaller perturbations ($K_p < 5$) the temperature T shows a nearly linear dependence on K_p, and for latitudes lower than 55° the rate of change $\Delta T/\Delta K_p$ is about 28°. For latitudes above 55° (average: 65°) $\Delta T/\Delta K_p$ seems to be about 15 to 25% greater. For more intense disturbances ($K_p \geq 5$), $\Delta T/\Delta K_p$ is systematically larger, confirming the nonlinearity of the relation between T and K_p, when considered over its total range; there is also a good indication that some atmospheric perturbations are enhanced in the auroral zones more than others. (auth)

18527 HYDROMAGNETIC GRADIENT WAVES IN THE IONOSPHERE. Tolstoy, I. (Columbia Univ., Dobbs Ferry, N. Y.). J. Geophys. Res., 72: 1435-42(Mar. 1, 1967).

Hydromagnetic gradient (HMG) waves are a magnetohydrodynamic analog of Rossby waves. It is shown here that conditions for their existence are approximately satisfied in the so-called dynamo layer of the atmosphere. As a result, it appears plausible to assume the existence of HMG waves as traveling perturbations of the S_q current system. Corresponding micropulsations of the earth's magnetic field are estimated and may be measurable. (auth)

18528 SPORADIC E AND THE WIND STRUCTURE OF THE E REGION. Wright, J. W. (Inst. for Telecommunication Sciences and Aeronomy, Boulder, Colo.); Murphy, C. H.; Bull, G. V. J. Geophys. Res., 72: 1443-60(Mar. 1, 1967).

Observations of neutral winds from visible trails of gun-launched vehicles and radio soundings of the ionospheric sporadic E layers are described and compared. It is shown that the wind structure accounts for many features of the sporadic E layer variation on two nights of observation, through the vertical ion convergence mechanism described most recently by MacLeod (1966). Except for some transient disagreements, the sporadic E is found to accompany the height variation of certain levels of zero ion velocity induced by the neutral wind. The peak electron number density of the layers diminishes when the wind structure leads to ion divergence at the sporadic E height, and the density is observed to increase when the ion velocity permits the descent of "new" ionization from above. New layers "arrive" at night in accord with the observed development and descent of new nodes of ion convergence. The daytime evolution of a principal sporadic E layer is described and related to its subsequent nighttime association with the wind structure. Together with other published evidence that similar layers consist of long-lived monatomic ions ultimately from meteoric influx, it is concluded that the neutral wind serves as a scavenger of this material that would otherwise accumulate to a far higher ionic concentration in the upper atmosphere. (auth)

18529 ENTRY OF SOLAR COSMIC RAYS INTO THE POLAR CAP ATMOSPHERE. Hakura, Yukio (Radio Research Labs., Tokyo. Goddard Space Flight Center, Greenbelt, Md.). J. Geophys. Res., 72: 1461-72(Mar. 1, 1967).

Worldwide f_{min} records are used to analyze onset patterns of PCA owing to enhanced ionization caused by penetrating solar particles. The initial phase of PCA consists of at least three characteristic stages that occur successively in different zones of the polar region: the first stage is observed as a slightly enhanced ionization near the geomagnetic pole; the second stage as a remarkable development of PCA in the polar cap above 65° (corrected geomagnetic latitude); and the third stage as an extension of the enhanced ionization down to latitudes of 60° or lower. A diffusion model of interplanetary space suggests that the three stages are due to differential arrival of solar electrons, protons, and α particles at the polar atmosphere. The importance of α particles to the third stage is established by using known incident spectra of both solar protons and α particles. An empirical relation between particle rigidity and geomagnetic latitude shows a uniform reduction of the Störmer rigidity cutoff by some 70% in the interval 55–65° in corrected geomagnetic latitude and a disappearance of cutoff in the polar cap above 65°. The former suggests quiet-time ring current, while the latter may be explained either by a direct merging of the polar cap magnetic field with the interplanetary field or by a particle-energy coupling due to a diffusion process such as in a postulated long geomagnetic tail. Onset patterns of PCA are used as a test for these theoretical models of the geomagnetosphere. Transient times of a few hours usually required for the first and second stages seem to favor the particle-diffusion model. (auth)

18530 POSITIVE ION COMPOSITION OF A TEMPERATE-LATITUDE SPORADIC E LAYER AS OBSERVED DURING A ROCKET FLIGHT. Young, J. M.; Johnson, C. Y.; Holmes, J. C. (Naval Research Lab., Washington, D. C.). J. Geophys. Res., 72: 1473-9(Mar. 1, 1967).

An Aerobee rocket carrying a positive ion composition experiment traversed a dense sporadic E layer on both the up- and down-leg portions of flight. The results of the experiment suggest that the positive ions comprising this layer were of a metallic nature. NO^+, the dominant E-region ion at the time of flight, was undetected within the sporadic E layer, although it was the major ion both immediately above and below it. The results of the experiment are compared to some theoretical predictions from the wind-shear theory of sporadic E. (auth)

18531 SECONDARY PROCESSES IN PROTON AURORAS. Eather, R. H. (Rice Univ., Houston, Tex.). J. Geophys. Res., 72: 1481-9(Mar. 1, 1967).

In ordinary proton auroras, D-region photoionization by HL$y\alpha$ and E-region photoionization by HL$y\beta$ are found to be unimportant compared with the direct ionization. Secondary ionization contributes only about 7% of the total ionization, and secondary excitation of λ3914 N_2^+ contributes about 1.5% of the total λ3914 N_2^+ emission. The λ5577 OI intensity in proton auroras is estimated to be 7 to 20 times the Hβ intensity. Photoionization processes are also unimportant in polar-glow auroras, but excitation and ionization by secondary electrons are as important as the direct excitation and ionization. (auth)

18532 POLAR MAGNETIC SUBSTORMS. Atkinson, G. (California Inst. of Tech., Pasadena). J. Geophys. Res., 72: 1491-4(Mar. 1, 1967).

The magnetic aspects of a theory of polar substorms that was previously presented are developed. The flow of flux tubes associated with a substorm is considered. It is suggested that the polar magnetic substorm current system is the superposition of the usual Hall current system and the westward electrojet, which is Pedersen current produced by the southward motion of field line feet across the high conductivity strip resulting from auroral deposition. (auth)

18533 TRAPPED RADIATION SHELLS AND COSMIC-RAY CUTOFFS IN MODELS OF THE MAGNETOSPHERE. Friedland, Allan B. (Center for Radiophysics and Space Research, Ithaca, N. Y.). J. Geophys. Res., 72: 1495-1511(Mar. 1, 1967).

Ray has found an approximate first integral for the motion of charged particles in static magnetic fields that do not necessarily display axial symmetry. This involves a canonical transformation to a new set of coordinates, one of which is approximately ignorable. A corrected version of the Lagrange equation of this coordinate is derived here by a perturbation technique, using energy conservation, adiabatic invariance of the magnetic moment, and Ray's first integral as the zeroth-order solution. Application of Alfvén motion to the zeroth-order trajectory is then made to obtain a corrected version of the approximate first integral. The resulting quadrature predicts a splitting of the invariant magnetic shells on which the guiding centers of trapped radiation reside. This result was first predicted by Stone, but had previously been untractable by the McIlwain L parameter when applied to models of the magnetosphere severely distorted by the "solar wind" plasma. The corrected Lagrange equation is further used to derive a new method for calculating cosmic-ray cutoffs on the surface of the earth. This method replaces the traditional Störmer theory and its further refinements put forward by other authors. (auth)

18534 EXPLORING THE ATMOSPHERE WITH NUCLEAR EXPLOSIONS. Donn, William L.; Shaw, David M. (Columbia Univ., Palisades, N. Y.). Rev. Geophys., 5: 53-82(Feb. 1967).

Pressure waves from large nuclear explosions were recorded at many stations over the earth by instruments installed by the Lamont Geological Observatory. The propagation of these waves is controlled primarily by gravity and the acoustic properties of the atmosphere in a manner that produces group velocity dispersion of the acoustic–gravity modes making up the signal. The nature of the wave dispersion depends on both the thermal and the wind stratification of the atmosphere. The causal relationships were studied both experimentally and theoretically. To provide more data for air–wave investigations, the 208 Lamont records made at 15 stations from 45 nuclear explosions are presented, together with related data on source, times, and distances. (auth)

18535 SOLAR WIND AND INTERPLANETARY MAGNETIC FIELD. Dessler, A. J. (Rice Univ., Houston, Tex.). Rev. Geophys., 5: 1-41(Feb. 1967).

A brief history is presented of some ideas regarding the solar wind. The basic physical principles of supersonic expansion are discussed. An analogy is drawn with the flow of an ideal gas through a rocket-engine nozzle. Supersonic expansion of a stellar corona requires a stellar and coronal temperature lower than a specified maximum. For temperatures above this maximum, subsonic expansion should result. The thermal structure of the sun is such that only supersonic expansion occurs although subsonic expansion is, in principle, allowed. The present status of relevant experiments and theory regarding the solar wind and interplanetary magnetic field is discussed. In particular, attention is drawn to a comparison between theoretical predictions and actual measurements. It is concluded that measurements are consistent with theory for the component of field projected on the ecliptic plane. However, a serious discrepancy is noted between theory and experiment with regard to a possible component perpendicular to the sun's equatorial plane. Wave motion in the solar wind is discussed briefly. It is shown that, under certain conditions, relative wave amplitudes should grow with increasing heliocentric distance. Finally, ideas concerning the ultimate fate of the supersonic solar wind are reviewed. (auth)

18536 LOW-ENERGY CHARGED PARTICLE ENVIRONMENT OF THE EARTH. Hess, W. N.; Mead, G. D.; Nakada, M. P. (Goddard Space Flight Center, Greenbelt, Md.). pp 327-63 of Thermophysics and Temperature Control of Spacecraft and Entry Vehicles. Heller, Gerhard B. (ed.). New York, Academic Press, 1966.

The present state of knowledge of the low energy particle fluxes found in space near the earth is reviewed with emphasis on those

particles which might cause degradation to thermal control surfaces. The solar wind blowing outwards from the sun is composed largely of protons of about 1 keV. This wind blowing against the geomagnetic field distorts it into an elongated cavity called the magnetosphere. Outside this cavity a turbulent boundary layer exists and upstream a collisionless shock wave. In the boundary layer large fluxes of electrons are accelerated up to 10 keV and more. Inside the magnetosphere in the outer portion of the Van Allen radiation belt are large fluxes of both protons and electrons of 10 to 1000 keV. Low energy magnetospheric particle populations have not been well surveyed yet but large proton fluxes of ~1 keV energy probably exist in the inner belt especially at times of magnetic storms. Some of these particle fluxes seem large enough to damage sensitive surfaces in times of hours to days. (auth)

18537 A DETERMINATION OF THE NEUTRAL COMPOSITION, DENSITY, AND TEMPERATURE OF THE UPPER ATMOSPHERE FROM 120 TO 200 KILOMETERS WITH ROCKET-BORNE MASS SPECTROMETERS. Hedin, Alan Edgar. Minneapolis, Univ. of Minnesota, 1966. 141p.

Thesis.

Three magnetic mass spectrometers were carried aboard an Aerobee rocket fired from the White Sands Missile Range on April 15, 1965 at 0345 MST. The ion sources of two of the spectrometers shared a common volume, which was connected to the atmosphere by an orifice, on the side of the rocket, at the end of a short cylindrical tube (closed source geometry). One of these spectrometers swept rapidly over the mass 28 peak only. The second spectrometer had two collectors, so the mass range 1 to 8 could be swept simultaneously with the mass range 10 to 80. The third spectrometer was similar to the second, only its ion source was exposed as directly to the atmosphere as mounting limitations would allow (open source geometry). The peak heights obtained from the spectrometers were theoretically related to ambient number densities and temperature by means of a formula which depends on rocket orientation, velocity relative to the atmosphere, and the gas inlet and source geometry. The amplitude of the spin modulation of the peak heights is directly related to the ambient temperature, providing the basis for estimating temperature, independent of the density gradient. The model for the closed source geometry was essentially based on the usual orifice pressure probe theory, modified by the transmission probability (calculated by the Monte Carlo method) of the short cylinder connecting orifice and spectrometer volume. The open source geometry was approximated by two cylinders, and was analyzed by finding numerical corrections to an exact theory for a spherical source model. The number densities for N_2, O_2, O, Ar, and He were found. The atomic oxygen density was unexpectedly low. Since the open source geometry was similar to that used on a previous flight, which found 3 to 4 times higher atomic oxygen density, this is probably a real change in atmospheric composition. Diffusive equilibrium density distributions were calculated using the temperature found by integrating the total mass density. The agreement with the measured N_2, O_2, O, and Ar densities was very good. The temperature distribution obtained from the least squares fit of the peak heights was somewhat higher than the temperature obtained by integrating mass density, and this was attributed primarily to uncertainty in the proper residual correction to be made for each peak. It was found that less than 1% of the ambient atomic oxygen reached the ion source in the closed source geometry and that less than 15 to 25% of that lost could be attributed to true recombination, since the O_2 density in the closed source geometry was not significantly enhanced over that in the open source. (Dissertation Abstr.)

18538 INTERACTION BETWEEN THE SOLAR WIND AND THE GEOMAGNETIC FIELD. Hurley, James Patrick. New York, New York Univ., 1961. 82p.

Thesis.

There is now considerable evidence for the existence of an interaction between the solar wind and the geomagnetic field. The solar wind is a highly ionized plasma and as such may well influence the earth's magnetic field. It is this interaction that was studied. The study was limited to a two dimensional model to permit an exact solution to be obtained. The plasma wind is considered as impinging upon an arbitrarily oriented two dimensional magnetic dipole. It was found that the field is compressed by the plasma and essentially confined to form a cavity in the plasma wind. The thickness of the boundary layer within which the plasma and field interact is found to be small. The equation of this boundary surface and the extent to which the field is changed by such a confinement are determined. The stability of such a system is considered. Results indicate that there are certain regions of instability, but for the part of the surface facing the wind it is stable. (Dissertation Abstr.)

18539 GRAVITATIONAL TIDE CONTROL AND SOLAR RADIATION CONTROL OF THE GEOMAGNETIC FIELD. Gupta, Jagdish Chandra. Los Angeles, Univ. of California, 1966. 188p.

Thesis.

The lunar geomagnetic diurnal lines $2Q_1^m$ and σ_1^m, Q_1^m and ρ_1^m, O_1^m, M_1^m, θ_1^m and J_1^m, SO_1^m and OO_1^m, ν_1^m, the semidiurnal lines $3N_2^m$, $2N_2^m$ and μ_2^m, N_2^m, M_2^m, L_2^m and the terdiurnal lines M_3^m, M_3^m and M_3^m were discovered through a high resolution spectrum analysis of the geomagnetic field data. The statistical significance of these lines is verified. The computed amplitudes of these lunar geomagnetic lines (called gravitomagnetic lines and specified by superscript m) were found to be larger in the higher latitudes as compared to those at the lower latitudes. At the equatorial stations, the amplitudes of the line M_2^m were found maximum and at the frequency of this line, the coherence γ_{GM} is found closer to unity, establishing a linear relationship between the geomagnetic and the gravitational tide time series. The source of excitation of the gravito-magnetic lines was identified to be of gravitational origin, because such periodicities are known to exist only in the gravitational potential. It is emphasized that the theory of the equilibrium tide can adequately explain the lunar geomagnetic variations. It was shown, through computations of the partial coherence function, that (1) the contribution to the solar semidiurnal geomagnetic variations of the gravitational tide and the solar radiation (thermal function) are about 10 and 90%, respectively, (2) the thermal contribution to the solar diurnal geomagnetic variations is about 99%; the gravitational tide contribution being negligible. The 27-day harmonics were successfully resolved and their statistical significance verified. The presence of these harmonics indicates that the active regions exhibit a tendency to exist concurrently and equally separated in solar longitude. Also, the calculations show that during the IGY/IGC period, the active regions were predominantly present between approximately 20–21° heliographic latitude. On the basis of the presence of the peaks corresponding to the seasonal changes in the spectra of the ranges r and R′, Cortie's "Axial Hypothesis" was supported. This hypothesis explains the observed annual and semi-annual geomagnetic variations. It is suggested that cause of the observed daily variability in the amplitude and the type of the equatorial electrojet current system are due to the irregularities in the influx of solar ultraviolet radiation. A satellite experiment was suggested to study the daily variations in the uv-radiation. Also, the calculations show that the intensity of the equatorial electrojet during IGY reached about 9 times as high as that during the preceding minimum activity period. A detailed study of the S_q -current system led to the conclusion that in a "strong" sunspot cycle the intensity rises to maximum in about four years and falls to the subsequent minimum in the following seven years, but in a "weak" sunspot cycle the rise and fall in the intensity are about equally rapid. (Dissertation Abstr.)

18540 LOW-FREQUENCY COMPONENTS OF THE GEOMAGNETIC FIELD. Currie, Robert Guinn. Los Angeles, Univ. of California, 1966. 146p.

Thesis.

Under simplifying assumptions, the spectral transfer function for a two layer model of the mantle is obtained whose absolute value, with geometrical attenuation removed, yields the physical attenuation. By varying the mean conductivity and thickness of the lower mantle, the shielding properties of the mantle as a function of frequency are investigated in detail. The mantle time constant provides comparisons with previous investigations. From the transfer function and measured power spectra, the magnetic power spectrum at the core-mantle boundary is computed for a narrow frequency range (3.7 to 22 years). For periods less than 3.7 years the problem of computing core spectra is indeterminate because, on the basis of trend free power spectra, it is deduced that these periods are effectively cut off by the mantle. Severe secular variation impulses are found to be clustered circa 1900, 1913, 1931, 1937 and 1955, and show some correlation with irregular variations in length of day. It is suggested that the 5 year recurrence tendency for impulses may be due to the 5.5 year solar subharmonic. Trend free power spectra, obtained from a world wide distribution of magnetic observatories with long and continuous records, have resolved several new lines in the geomagnetic spectrum. The 54-day line is statistically significant and has a mean amplitude of 1.4γ. The origin of the semiannual line, on the basis of cross-spectra and other supporting evidence, is interpreted as being due to the quiet time proton belt. The annual line must, however, have a fundamentally different generating mechanism which is probably situated in the ionosphere. A previously reported quasi-biennial line is found not to exist. Existence of the solar cycle subharmonic is suggested, but its statistical significance is in doubt. The cross-spectrum between H and Z for many observatories generally yields low coherence and fluctuating phases for both the semiannual and annual lines, and cast doubt on the use of these long periods to improve upper mantle conductivity estimates by Eckhardt's method. A few of the (D,H) data have been

transformed into geomagnetic coordinates (X',Y'). The noise level for X' (north) is about one order of magnitude higher than for Y' (east). The Y' line spectra are statistically significant and, for the semiannual line, may be observational evidence for meridional currents in the magnetosphere. (Dissertation Abstr.)

18541 ADIABATIC MOTION OF CHARGED PARTICLES IN A MODEL OF THE GEOELECTRIC AND GEOMAGNETIC FIELDS. Taylor, Harold Evans. Iowa City, Iowa, Univ. of Iowa, 1966. 134p.

Thesis.

Calculations of charged particle motions were carried out in a model of the earth's magnetosphere which includes both a magnetic field and an electric field. The magnetic field was based on extensive satellite measurements of the real geomagnetic field, and the electric field was deduced in the ionosphere from ionospheric current systems and mapped throughout the magnetosphere by assuming that the magnetic field lines are equipotentials. Using this model the motions of charged particles were calculated by assuming that the first two adiabatic invariants, μ and J, and the total energy K are all conserved. Particle fluxes are then calculated by invoking Liouville's theorem. The computations were done numerically on the University of Iowa, IBM 7044 computer and the results obtained for outer zone electrons are shown to be in agreement with experimental measurements of the Injun 3 satellite. Specifically, the contours of constant intensity of $\gtrsim$40-keV trapped electrons predicted on the basis of the model are in agreement with the contours found by Frank et al., [1964] with Injun 3. Also the profiles of intensity versus latitude predicted on the basis of the model are in agreement with the experimental curves of Armstrong [1965] for both electrons $\gtrsim$40 keV and electrons $\gtrsim$230 keV, although the curves for the different particle energies are quite different. The good agreement between calculations based on the model and experimental measurements is taken to imply that the assumptions made are valid at least for electrons in the outer radiation belt. The agreement for energetic electrons ($W_e \gtrsim 230$ keV) indicates that the magnetic field is a good representation of the real magnetic field and also that the particle motion may be assumed to be adiabatic. The inclusion of a magnetospheric electric field is the unique feature of this work which is shown to reproduce the observed energy dependent features of the spatial distribution of outer zone electrons. This agreement between calculations and observation, in turn, implies that the electric field used must be a reasonable representation of the real electric field. Predictions of as-yet-unmeasured quantities are presented for comparison with future experiments. Specifically, the fluxes of 10-keV electrons at low altitudes are calculated, as are fluxes of 10- and 50-keV electrons in the equatorial plane. Also, the expectations for trapped protons at low altitudes are presented. (Dissertation Abstr.)

Low-Temperature Physics

Refer also to abstract 19087.

18542 (BNL–9809) THERMAL AND THERMODYNAMIC PROPERTIES OF RETAINED FLUX IN HYSTERETIC SUPERCONDUCTORS. Schweitzer, Donald G. (Brookhaven National Lab., Upton, N. Y.). [1964]. Contract AT(30-2)-Gen-16. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The temperature dependence of the retained ("trapped") flux in a number of different superconducting systems was determined from magnetic field cycling (cooling) experiments and from thermal cycling (heating) experiments. Both techniques yield the same retained flux for Nb, Pb, and all the Pb–Bi, Pb–In, and Sn–Sb alloys studied. Cold working and annealing affect the magnitude of the retained flux, but do not change the temperature dependence of retained flux in any system. The retained flux immediately responded to temperature increases over the total temperature range investigated (1 to 4.2°K). The usual form of the flux creep model does not explain these observations. Furthermore, an analysis of the flux creep formulation shows both internal inconsistencies as well as inconsistencies with conventional rate process theory. An alternative explanation is proposed. (auth)

18543 (NP–16638) MINIMAL THEORY OF ULTRASONIC ATTENUATION IN SUPERCONDUCTORS. Technical Report No. 604. Ferrell, Richard A. (Maryland Univ., College Park. Dept. of Physics and Astronomy). July 1966. 5p.

The conventional formula for ultrasonic attenuation of longitudinal waves in superconductors is usually derived from the coherence factors of the BCS theory. It is noted that this formula has in actuality a much more general foundation. With an alternative deformation potential approach, the detailed properties of the superconductor do not enter and the result depends only upon the minimum energy in the spectrum of the elementary excitations. (auth)

18544 (NP-tr–1511) CURRENT STABILITY CRITERIA IN COMPOSITE (NORMAL + SUPERCONDUCTING) CONDUCTORS. Keilin, V. E.; Klimenko, E. Yu.; Kremlev, M. G.; Samoilov, B. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Culham Lab., Abingdon, Eng., from report IAE–1208. 11p. (CTO–346). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

For the purpose of a quantitative estimate of the reversibility criteria of the transition of superconducting solenoids to the normal state, a simplified model is considered, namely, an infinite conductor (normal metal, in thermal and electrical contact with the superconductor) with a point heat source. The conditions for stability of the current in such a conductor are deduced. (auth)

18545 ANOMALOUS RESISTANCE OF PURE GALLIUM NEAR 1.7°K. Newbower, R. S.; Neighbor, J. E. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 18: 538-40 (Apr. 3, 1967).

The electric resistivity of large single crystals of 99.9999+% gallium was found to exhibit anomalous behavior near 1.7°K. The temperature at which the anomaly occurs decreases extremely rapidly with increasing magnetic field. Measurements were made with currents as small as 0.005 A, using a potentiometric system with 10^{-15} volt sensitivity. (auth)

18546 QUANTUM PHASE CORRELATION IN SMALL SUPERCONDUCTORS. Hunt, T. K.; Mercereau, J. E. (Ford Motor Co., Dearborn, Mich.). Phys. Rev. Lett., 18: 551-3 (Apr. 3, 1967).

For very narrow tin films a depression of the superconducting transition temperature was observed below that of wider portions of the same films. A model is proposed which accounts for this depression and also suggests a condition on the maximum microwave enhancement of critical current in narrow thin-film bridges as previously observed. (auth)

18547 SUPERCONDUCTIVE MATERIALS AND MAGNETS: A REVIEW OF PROGRESS AT RCA. Freedman, N. S. (Radio Corp. of America, Harrison, N. J.). RCA Eng., 12: 7-10 (Dec. 1966-Jan. 1967).

The development of Nb_3Sn-coated superconducting ribbons and the application of these superconductors to high-field magnets having practical working bores are reviewed. A chronological listing of significant developments, given in a table, provides an overall view of industry progress and technological developments in the field of very-high-field superconductive magnets. As an illustration of magnet-field requirements that can only be attained practically and economically with superconductive magnets, the plans of the Argonne National Lab. for a low-field 25-KG, 15.5-ft bore magnet for the 12-ft hydrogen bubble chamber are described. This magnet will require 6×10^8 ampere-turns at an average dia of 16.5 ft for a total of 135,000 ft of 3000-A conductor. A nonsuperconductive water-cooled Cu magnet would require a prohibitive 10 MW of continuous power to overcome the finite electrical resistance in the conductor windings. Also described are the large-bore superconductive magnets in use at the Brookhaven National Lab. Available at present for use with such magnets are Nb_3Sn ribbons 0.5 in. wide and 0.0042 in. thick, capable of carrying from 350 to more than 1200 A at 100 KG (1150 to 4000 A at 25 KG). Rapid progress is also being made in the development of low-field superconductive magnets. Recent developments in large-bore low-field superconductive magnets are also reported. (BBB)

18548 DESIGN AND CONSTRUCTION OF Nb_3Sn SUPERCONDUCTIVE MAGNETS. Schrader, E. R. (Radio Corp. of America, Harrison, N. J.). RCA Eng., 12: 19-23 (Dec. 1966-Jan. 1967).

Superconductive magnets, like conventional Cu magnets, develop magnetic fields by current flow in a conductor. However, the use of liquid He to achieve zero resistance at 4.2°K makes the technology of superconductive-magnet design different from that of conventional magnets in which power is dissipated. This technology is discussed along with an example of the construction of a superconductive-magnet system designed to achieve 150 KG in a 6-in. bore. The following requirements for the design of a practical magnet are considered: (1) A mathematical method for calculating the magnet fields and forces in space as a function of the current density and the geometry of the windings; (2) Data on the current-carrying capacity of the conductors in magnetic fields and under stress; and (3) Means of rigidly holding the conductors to the desired geometry and of providing access for electrical leads and cooling media. The conventional solenoid geometry

where a magnetic field is developed within the center of the windings is described. Other types of field geometries require modified types of windings. For instance, magnetohydrodynamic apparatus requires a magnetic field directed at right angles to ionized gas flowing in a pipe. This requirement is usually met by distortion of the windings into saddle shapes around the pipe. Other winding modifications are designed to yield very high magnetic-field gradients to enable high-energy charged-particle accelerator beams to be focused. The design techniques needed for these applications are based upon the need for current density, adequate cooling, stability, safety, and strength. Each magnet application stresses these features differently, e.g., a magnet which is to be used around a potentially explosive liquid-hydrogen bubble chamber must be exceptionally stable and safe; a magnet needed for the highest possible field in the smallest volume will stress current density. (BBB)

18549 SUPERCONDUCTING ENERGY GAP IN SINGLE CRYSTAL DOPED TIN. Claiborne, L. T.; Einspruch, N. G. (Texas Instruments Inc., Dallas). Mater. Res. Stand., 1: 143-50(Nov. 1966).

A detailed study was made of the energy gap and gap anisotropy in a variety of In-, Sb-, Bi-, and Cd-doped Sn single crystals with impurity concentrations ranging from 1 to 5000 ppM. The gaps were measured in the [001], [110], and [100] directions using the temperature dependence of the compressional wave ultrasonic attenuation. The measured anisotropy between the [110] and [001] directions for pure Sn was ~20% of the average energy gap. It was found that this anisotropy is reduced to ~2% for values of ρ, the inverse resistivity ratio, $\geq 10^{-2}$ and for $\Delta T_c > 15$ m°K. The Bardeen–Cooper–Schrieffer theory, which was developed for isotropic, weak-coupling superconductors, was applicable to the most heavily doped samples. It was found that the energy gap ($\sim 1.76\ k_B T_c$) and the temperature dependence of ultrasonic attenuation are in agreement with the predictions of the theory. (BBB)

18550 SECOND-SOUND ATTENUATION IN ROTATING HELIUM II CLOSE TO THE LAMBDA POINT. Lipa, J. A.; Pearce, C. J.; Jarman, P. D. (Univ. of Western Australia, Nedlands). Phys. Rev., 155: 75-7(Mar. 5, 1967).

The attenuation of second sound in rotating resonant cavities containing helium(II) has been measured in the temperature range $10^{-1} > T_\lambda - T > 6 \times 10^{-4}$°K, and values of Hall and Vinen's parameter B have been calculated from these data. The results show that B is only slightly temperature-dependent, in qualitative agreement with the predictions of Pellam, but in disagreement with the theories of Hall and Vinen and of Lifshitz and Pitaevskii. (auth)

18551 LONG-RANGE ORDER IN SUPERFLUID HELIUM. Kane, J. W. (Cornell Univ., Ithaca, N. Y.); Kadanoff, L. P. Phys. Rev., 155: 80-3(Mar. 5, 1967).

Fluctuations in the phase of the condensate wave function appearing in the single-particle Green's function for a condensed Bose system are examined in one, two, and three dimensions. The results indicate that at nonzero temperatures, long-range order will appear only in three dimensions. (auth)

18552 PHONONS AND THE PROPERTIES OF A BOSE SYSTEM. Reatto, L.; Chester, G. V. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-2391. Phys. Rev., 155: 88-100(Mar. 5, 1967). (NYO-2391-34).

A new ground-state wave function and low-temperature density matrix for a strongly interacting system of bosons is suggested. The basic assumption is that the system can support long-wavelength phonons and that these can propagate independently of any other mode of motion. Therefore the ground-state function is written as the product of two factors. One factor arises from the zero-point motion of the phonons, and it is shown that it has the form $\Pi_{i<j} f(r_{ij})$, where ln f(r) has an infinite range. The other factor is assumed to have this same form but with ln f(r) of finite range; it takes into account the short-range correlations arising from the strong repulsive part of the interparticle potential. The function chosen to represent the short-range correlations is not new; functions of this kind were first introduced by Bijl and later by Jastrow. At finite temperatures a density matrix is used for an ensemble of excited phonon states. It is found that for small wave vectors k, the structure factor S(k) is equal to $\hbar k/2mc$, a result first derived by Feynman. At a finite temperature T, S(k) tends to the constant value $k_B T/mc^2$, where m is the mass of the particles and c the velocity of propagation of the phonons. The momentum distribution n_k has a k^{-1} singularity at absolute zero and a stronger, k^{-2} singularity at finite temperatures. The small-k behavior of both S(k) and n_k is completely controlled by the correlations introduced by the phonons. Both the ground-state function and the density matrix imply that there is a finite fraction of particles in the zero-momentum state in three dimensions; this fraction does not seem to be appreciably affected by the infinite-range correlations introduced by the phonons. It is found, however, that these correlations imply that a one-dimensional Bose system does not exhibit Bose–Einstein condensation at any temperature, while a two-dimensional system exhibits Bose–Einstein condensation only at absolute zero. (auth)

18553 EFFECTS OF PRESSURE ON THE TRANSPORT OF IONS THROUGH ROTATING HELIUM II. Springett, B. E. (Univ. of Chicago). Phys. Rev., 155: 139-?(Mar. 5, 1967).

Measurements of the cross section for capture of negative ions by vortex lines in He(II) and of the mobility of the negative ion, as a function of both pressure and temperature, are described. The first of these measurements is used to derive the variation of the negative-ion radius with pressure. The bubble model of the negative ion is then discussed in the light of the derived radii and an explanation of the mobility measurements is given. Certain null results on positive ions are also presented. (auth)

18554 NEW SOLUTION OF THE BCS GAP EQUATION. Rothwarf, A. (RCA Labs., Princeton, N. J.). Phys. Lett., 24A: 307-8(Mar. 13, 1967).

A new solution of the BCS gap equation is given. The role of the cutoff energy and interaction potential are clarified. Results very similar to the BCS theory are obtained. (auth)

18555 FLUXON SIZE IN THIN FILMS. Sherrill, M. D. (General Electric Co., Schenectady, N. Y.). Phys. Lett., 24A: 312-13(Mar. 13, 1967).

The behavior of magnetically coupled superconducting films indicates that the fluxon size is a decreasing function of film thickness when the film thickness is of the order of the penetration depth. (auth)

18556 LOW-TEMPERATURE STRUCTURAL TRANSFORMATION IN Nb_3Sn. Mailfert, R. (Cornell Univ., Ithaca, N. Y.); Batterman, B. W.; Hanak, J. J. Phys. Lett., 24A: 315-16(Mar. 13, 1967).

The compound Nb_3Sn undergoes a structural transformal at $T_M = 43$°K from cubic A15 to a tetragonal low-temperature phase, with a > c (V_3Si: c > a) and a distortion from the cubic some 2.5 times greater than V_3Si. (auth)

18557 NONLINEARITY IN THE VOLTAGE-CURRENT CHARACTERISTIC OF A TYPE-II SUPERCONDUCTOR. Jones, R. G.; Rhoderick, E. H.; Rose-Innes, A. C. (Univ. of Manchester, Eng.). Phys. Lett., 24A: 318-19(Mar. 13, 1967).

The curvature of the V–I characteristic of a type-II superconductor at currents just above the critical current may arise from nonuniformity of the sample, even if the basic mechanism producing the voltage is linear in the current. (auth)

18558 LOW-TEMPERATURE SPECIFIC HEAT OF LIQUID ^{3}He. Brenig, W.; Mikeska, H. J. (Max-Planck-Institut fuer Physik, Munich. Technische Hochschule, Munich). Phys. Lett., 24A: 332-3(Mar. 13, 1967).

The spin fluctuation contribution to the T^3 ln T term in the specific heat of ^{3}He is expressed in terms of the renormalized Landau parameters $J_0 = F_0^a$ and $J_1 = F_1^a = F_1^s$. (auth)

18559 ADVANCES IN SUPERCONDUCTING MAGNETS. Sampson, William B.; Craig, Paul P.; Strongin, Myron. Sci. Amer., 216: No. 3, 115-23(Mar. 1967).

The developments in superconducting magnets over the past five years are outlined. The characteristics required of any superconductor for service in a high-field superconducting magnet are discussed. Problems involved in using these magnets are reviewed and some speculation on their future possibilities is included. (M.H.R.)

18560 QUANTIZATION OF CIRCULATION IN A NON-IDEAL BOSE GAS. Pollock, F. (Stevens Inst. of Tech., Hoboken, N. J. Columbia Univ., Dobbs Ferry, N. J.). Phys. Fluids, 10: 473-8(Mar. 1967).

The dilute Bose gas is considered in the Bogolyubov approximation for the purpose of accounting for the quantization of circulation for the entire superfluid. It is found that the states of lowest energy have the motion of the entire system governed by the condensate. (auth)

18561 ON THE COLLECTIVE EXCITATIONS OF SUPERCONDUCTORS WITH THE P PAIRING. Czerwonko, J. (Univ., Wroclaw). Physica, 32: 1953-77(Nov.-Dec. 1966).

The theory of collective excitations of superconductors with P pairing is developed. The starting point is the ground state of the Balian and Werthamer type with the isotropic energy gap. The collective excitations are obtained by use of the self-consistent field method applied by Bogolubov to S superconductors. In this case there is only one spin branch of excitations. Two-quasiparti-

cle excitations with the continuous energy spectrum, separated by a gap are obtained. If Coulomb interaction disappears, quasi-acoustic excitations with discrete energy spectrum result. If the interaction strength multiplied by level density at Fermi surface tends to zero, the dispersion law is the same as for S superconductors. By applying the same limit in the presence of a Coulomb interaction one obtains for sufficiently small pairs momenta the Langmuir frequency. In the last section the electrodynamics of a state with P pairing is considered. Among other results the gauge invariance of the Meissner effect is proved. All results are obtained without any special choice of the form of interaction. Some formulas in the paper are satisfied also for superposition of S and P pairing. (auth)

18562 SOME DIFFICULTIES ENCOUNTERED WITH SUPERCONDUCTING NIOBIUM–ZIRCONIUM COIL MAGNETS. Goedemoed, S. H.; Kes, P. H.; Jacobs, F. Th. A.; de Klerk, D. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 32: 1978-84 (Nov.-Dec. 1966).

During experiments with a superconducting niobium–zirconium coil magnet small irregular field fluctuations were noticed during the variation of the field. Some investigations were carried out on the occurrence of these fluctuations. It was found that they disappear below the lambda point. (auth)

18563 OSCILLATIONS IN THE VOLTAGE BETWEEN TWO WEAKLY CONNECTED CURRENT-CARRYING SUPERCONDUCTORS AS A FUNCTION OF THE APPLIED MAGNETIC FIELD. II. Omar, M. H.; de Bruyn Ouboter, R. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 32: 2044-50(Nov.-Dec. 1966).

A previous investigation of the behavior of current-carrying weak contacts between two superconductors in the resistive yet superconductive region has been extended using pure Sn droplet junctions. It is shown that persistent currents in a closed Nb ring can be determined sensitively, by means of measuring the voltage change, over an attached current-carrying weak contact in the resistive region, as a function of a magnetic field applied perpendicular to the plane of the ring. (auth)

18564 THE ONSET OF SUPERFLUIDITY IN UNSATURATED FILMS OF ^{4}He AND ^{3}He–^{4}He MIXTURES. Fokkens, K.; Taconis, K. W.; De Bruyn Ouboter, R. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 32: 2129-48(Nov.-Dec. 1966).

The onset of superfluidity in unsaturated ^{4}He films was measured for several film thicknesses between 0.8 and 1.7°K by measuring the critical transport of these films. Also the supercritical behavior and the heat resistance between a film and the wall, the Kapitza resistance, were examined. For mixtures, which had at room temperature a concentration of respectively 50%, 80%, and 90% ^{3}He, the onset of superfluidity was measured between 1.3 and 1.8°K. In this region also adsorption isotherms of these mixtures were measured. (auth)

18565 SUPERCONDUCTIVE MAGNETS. 2. APPLICATIONS. Montgomery, D. Bruce (Massachusetts Inst. of Tech., Cambridge). Mech. Eng., 89: No. 3, 36-43(Mar. 1967).

The properties, applications, technology and cryogenic considerations of superconducting magnets are reviewed. Some broad applications of superconductivity are grouped according to the basic principles which lead to them. (M.H.R.)

18566 SYMMETRY BREAKING AVERAGE AND FIELD THEORETICAL METHOD IN SUPERCONDUCTIVITY. Johansson, B. (NORDITA, Copenhagen). Physica, 32: 2164-70(Nov.-Dec. 1966).

By introducing an infinitesimally small source term into the Hamiltonian describing the system, one defines the notion of symmetry-breaking average (quasi-average). From this modified Hamiltonian the Pines field-theoretical equations for superconductivity are derived. The importance of the divergence of the t-matrix (describing repeated scattering of two particles with opposite momenta and spin) is pointed out. (auth)

18567 METHOD OF CORRELATION FUNCTIONS IN THE THEORY OF SUPERCONDUCTIVITY. IV. PARAMAGNETIC ADDITIVES. Lueders, Gerhart (Univ., Goettingen, Ger.). Z. Naturforsch., 21a: 1842-9(Nov. 1966). (In German).

The correlation-function method is extended to the case of paramagnetic impurities. The Boltzmann equation is obtained and subsequently applied to a derivation of the concentration dependence of the transition temperature, of the linearized Ginzburg–Landau equation, and of the diffusion approximation. (auth)

18568 GREEN'S FUNCTIONS METHOD FOR JUSTIFYING A NONEQUILIBRIUM LANDAU THEORY. Craig, R. A. (Univ. of Illinois, Urbana). Ann. Phys. (N. Y.), 40: 434-53(Dec. 1966).

A Landau theory which includes nonequilibrium situations is derived. The approach of Kadanoff and Baym is used to obtain a quasi-particle transport equation with collision terms. Landau's identifications of physical quantities as various moments of the quasi-particle distribution function are justified through the use of identities involving the functional dependence of the real time functions. These identities are derived using the concept of the ϕ-derivability of the real time functions discussed in an earlier work. (auth)

18569 UPPER-CRITICAL-FIELD LIMITS FOR BULK TYPE-II SUPERCONDUCTORS. Hake, R. R. (North American Aviation Science Center, Thousand Oaks, Calif.). Appl. Phys. Lett., 10: 189-92(Mar. 15, 1967).

Approximate zero-temperature upper-critical-field limits H_{c20} (max), consistent with the recent extreme-type-II theory of Werthamer, Helfand, and Hohenberg (WHH), are deduced by assuming (1) an electron mean free path l_0 comparable to the interatomic spacing, (2) a spin-orbit-coupling-induced spin-flip mean free path $l_{s0} = 2l_0$, with approximate applicability of the WHH theory in this domain, and (3) T_c and l-independent parameters typical of present-day high-field superconductors. Highest H_{c20} (max) ≈ 850 kG are obtained for high-T_c β-tungsten-structure compounds. (auth)

18570 QUANTUM FLUIDS. Proceedings of the Sussex University Symposium, 16–20 August, 1965. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966. 366p. $13.50. (CONF-650822).

Thirty-four experimental and theoretical papers on phenomena common to superconductivity and superfluid helium are included. Separate abstracts were prepared for twenty-six. (M.H.R.)

For abstracts of individual papers see: 18571–18596.

18571 SUPERFLUIDITY IN BOSE AND FERMI LIQUIDS. Nozieres, P. (Ecole Normale Superieure, Paris). pp 1-22 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The essential features of the phenomenon of superfluidity are reviewed. Special attention is paid to a comparison between neutral and charged systems (liquid helium and superconductors). This problem shows clearly the underlying unity of all superfluid systems. Another point made is the distinction between superfluidity and perfect (nonviscous) hydrodynamic flow. It is concluded that apparently the essential feature of all superfluid systems is the existence of a condensate, involving macroscopic occupation of a single quantum state. This condensate acts as a reservoir of particles; particles may dissolve in the condensate somewhere in the system and emerge at a remote point; hence the apparent nonconservation of particle number. (M.H.R.)

18572 STRONG FIELD EFFECTS AT THE SURFACE OF A SUPERCONDUCTOR. pp 26-67 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The strong field effects are considered in the light of De Gennes' model. Topics included were: surface barriers, density of states near the upper critical field, two-layer systems–magnetic effects on the superconducting side, and two-layer systems–magnetic effects on the normal side. (M.H.R.)

18573 TEMPERATURE DEPENDENCE OF UPPER CRITICAL FIELDS OF TYPE II SUPERCONDUCTORS. Kim, Y. B.; Strnad, A. R. (Bell Telephone Labs., Murray Hill, N. J.). pp 68-73 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

A rigorous extension of the GLAG theory to lower temperatures than the transition temperature has been possible only recently. A number of theoretical predictions on the temperature dependence of H_{c2} have been made. The $H_{c2}(T)$ predicted by these theories are compared with an extensive body of data taken on Nb, Nb–Ta, and Ti–V, for which the Ginzburg–Landau parameter values range from 0.9 to 100. The method of resistive transitions was used for these measurements. (M.H.R.)

18574 VORTICES IN SUPERFLUID SYSTEMS. Vinen, W. F. (Univ. of Birmingham, Eng.). pp 74-108 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

An overall picture of vortices in superfluid systems is presented. A general discussion of superfluid flow, of quantization of circulation and flux, and of various relevant coherence lengths is included. The basic idea of a free quantized vortex is introduced, first for an uncharged system and then for a charged system. The importance of such free vortices in describing both rotating helium and the mixed superconducting state is discussed. The detailed structure of a vortex, the dynamical properties of vortices, and problems associated with their creation and destruction are outlined. (M.H.R.)

18575 THEORY OF VORTEX MOTION IN SUPERCONDUCTORS. Bardeen, John (Univ. of Illinois, Urbana). pp 109-23

of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

When the forces produced by the transport current are sufficiently large to overcome pinning, the vortices move freely, subject only to viscous damping. Without going into mathematical details, the physical basis for the theory of the viscous motion is outlined, some of the problems about which controversy has arisen are discussed, and the outstanding problems which remain to be settled are reviewed. In particular, the roles of the Magnus force, the induction field created by the moving flux lines and the positive ion lattice, are discussed. Although the discussion is confined to superconductors, some of the ideas may be applicable to motion of vortex lines in He II when there is a relative motion of normal and superfluid components of the fluid. (M.H.R.)

18576 RESISTANCE AND HALL EFFECT IN THE INTERMEDIATE STATE; ANALOGY WITH THE MIXED STATE. Gorter, C. J. (Kamerlingh Onnes Laboratorium, Leiden). pp 125-7 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Equations are derived for the Hall effect and resistance for the intermediate state using the layer model. The equation for resistance is found to fit the data of the mixed state very well for $T \ll T_c$. The equation for Hall angle at least gives the right order of magnitude. (M.H.R.)

18577 COMMENTS ON PURE TYPE II SUPERCONDUCTORS. Volger, J. (Philips Research Labs., Eindhoven, Netherlands). pp 128-35 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The nature of the driving force on the flux lines is discussed. Only flux flow is considered, i.e., the phenomenon of the motion of all flux lines, moving uniformly because of the friction these flux lines feel when, under the action of the induced electric fields, they interact with excitations or "normal electrons" in their cores. Some experiments carried out on noise and transverse effects are summarized. Some general remarks are made on intrinsic transverse effects. (M.H.R.)

18578 RESISTIVITY AND HALL ANGLE IN THE MIXED STATE OF TYPE II SUPERCONDUCTORS. Van Vijfeijken, A. G. (Mullard Research Labs., Redhill, Eng.). pp 136-7 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Calculations were done for a type-II superconductor with Ginzburg–Landau parameter $\gg 1$. Some features of the model and the final results are given. It is found that the model is rather inadequate in the pure case. (M.H.R.)

18579 BUBBLE FORMATION ON VORTICES IN A LIQUID HELIUM BUBBLE CHAMBER. Edwards, M. H.; Cleary, R. M.; Fairbank, W. M. (Stanford Univ., Calif.). pp 140-5 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

It is believed that vorticity was produced in liquid helium II and that it was used to nucleate bubble formation. Most of the bubbles appeared to be round, and many had their outer edges near the inside wall of the glass cylinder. Many more vortices were detected at lower temperatures where they persisted longer. These first measurements did not measure the circulation but provided a method of locating a vortex rather precisely. The possibility is presented of determining whether these bubbles are in fact nucleated by quantized vortex rings by coupling this detection method with other techniques of vortex formation. (M.H.R.)

18580 SUPERCONDUCTING BARRIERS: THE PLASMA RESONANCE AND RELATED PROPERTIES. Josephson, B. D. (Cambridge Univ., Eng.). pp 174-9 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

A detailed study of the possibilities which can occur in the behavior of a barrier subject to oscillating fields but no steady fields is presented. Since no experimental work has been done along this line, some lines of investigation are suggested. (M.H.R.)

18581 OBSERVATION OF THE ANALOG OF THE A. C. JOSEPHSON EFFECT IN SUPERFLUID HELIUM. Richards, P. L. (Bell Telephone Labs., Murray Hill, N. J.). pp 180-2 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Two bodies of bulk superfluid were connected by a weak link. An ultrasonic modulation was applied to the superfluid which influenced the motion of vorticity in the neighborhood of the connecting link, and the current flow was measured as a function of an externally applied chemical potential difference between two bodies of bulk superfluid. (M.H.R.)

18582 EXPERIMENTAL PROPERTIES OF LIQUID ^{3}He AT VERY LOW TEMPERATURES. Wheatley, J. C. (Univ. of Illinois, Urbana). pp 183-218 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The principal experiments performed on liquid ^{3}He at very low temperatures are reviewed. A simple description of the nature of the experimental apparatus and what the experiments measure is given. On the whole, the results are interpreted in terms of Landau's theory of Fermi liquids. Measurements oriented toward a search for superfluidity in ^{3}He are discussed. A brief review is given of those experiments which bear on the region of temperature above that for which the characteristic temperature dependences of the Fermi liquid are observed for most parameters. No mention is made of the properties of ^{3}He–^{4}He mixtures or of the solid. (M.H.R.)

18583 INFLUENCE OF ZERO SOUND ON THE THERMODYNAMICS OF ^{3}He. Balian, R.; Fredkin, D. R. (CEN, Saclay, France). pp 219-23 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

A calculation was performed for ^{3}He, in which case the atoms interact with boson-like collective excitations of the zero-sound type. The calculation is based on the expression for the entropy in terms of the one-fermion propagator $G(k,\omega)$, which depends on the coupling Γ between atoms and collective excitations mainly through the contribution (I) to the mass operator, which is represented diagrammatically. The use of field-theory techniques was necessary, due to the importance of retardation effects. (M.H.R.)

18584 FERMI-LIQUID EFFECTS IN THE SUPERFLUID PHASE. Leggett, A. J. (Oxford Univ.). pp 224-5 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Most calculations of the properties of superfluid Fermi systems start from the model of a weakly interacting gas. How some of the results are modified when the system is treated as a Fermi liquid is discussed. For simplicity, the derivation is given for the special case of an isotropic translationally invariant system in which Cooper pairs are formed in a relative S state. (M.H.R.)

18585 SOLUBILITY OF ^{3}He IN LIQUID ^{4}He AT 0°K. Edwards, D. O. (Ohio State Univ., Columbus). pp 226-9 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Experiments on the form of the phase separation curve in liquid ^{3}He–^{4}He mixtures for low concentrations of ^{3}He are described. The heat capacity of dilute solutions were measured down to temperatures of the order of 0.1°K or less, both to check the applicability of the Landau–Pomeranchuk theory and to obtain values of the binding energy from the observed phase-separation temperatures, T_s, which appear as discontinuities in the specific heat. The measurements above the discontinuities, where only one phase is present, agree satisfactorily with the theoretical specific heat of a Fermi–Dirac gas with mass $m^* = 2.5\ m_3$ and with the same ^{3}He densities as the solutions, showing that the Landau and Pomeranchuk model is applicable even when the quasi-particle gas approaches degeneracy. (M.H.R.)

18586 REVIEW OF RECENT MICROSCOPIC THEORIES OF SUPERFLUID HELIUM. Martin, Paul C. (Harvard Univ., Cambridge, Mass.). pp 230-41 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Near $T \approx 0$, the homogeneous fluid is almost quantitatively understood, and some features of the inhomogeneous fluid are quantitatively understood. Near T_λ, neither is understood at all. In the region near T_λ, there is some hope that mathematical similarity with the classical-fluid critical problem, on which recent progress has been made, may be useful. But, for the present, there is no shortage of unsolved theoretical problems. The great morass of mathematical literature has, in fact, only scratched the surface. (auth)

18587 EXPERIMENTAL STUDIES OF INELASTIC NEUTRON SCATTERING FROM LIQUID HELIUM. Woods, A. D. B. (Chalk River Nuclear Labs., Ont.). pp 242-56 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Results obtained with a rotating crystal spectrometer for large values of neutron momentum transfer and for the temperature dependence of $\epsilon(p)$ at small momentum transfers are described. In both cases, theory has predicted interesting new phenomena. At large momentum, it has been predicted that the curve will have a horizontal tangent for $\epsilon \to 2\Delta$, and that the probability of single-quantum excitation will go to zero in this limit. The experiment supports this general picture. At small momentum, it has been predicted that the shape of $\epsilon(p)$ is very temperature-dependent near temperatures of ~2°K. Experiment shows that the slope is constant (within a few percent) even to temperatures above the λ point. (M.H.R.)

18588 ZERO SOUND IN LIQUID ^{4}He AND ^{3}He. Pines, David (Univ. of Illinois, Urbana). pp 257-66 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

A possible explanation is given of recent experiments on the variation with temperature of the energy and lifetime of certain long wavelength excitations in He(II) and He(I). Phonons of momentum 0.38 A^{-1} were studied. It was found that the phonon velocity is essentially independent of ρ_s in the superfluid regime; moreover, neither the energy nor the lifetime of the excitation changes appreciably on going from He(II) to He(I). Arguments are presented for a zero-sound mode in liquid ^{3}He and ^{4}He over a wide temperature region. (M.H.R.)

18589 BOUNDARY EFFECTS IN LIQUID HELIUM. Symonds, A. J.; Brewer, D. F.; Thomson, A. L. (Univ. of Sussex, Eng.). pp 267-70 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The main conclusions drawn from recent results on the specific heat of liquid helium confined within the pores of Vycor glass (pore diameter ~60 Å) in the temperature range 0.5 to 2.5°K are summarized. Experiments were performed with the pores full, and also with a number of different partial pore fillings. Analysis of the results showed that removal of a cylinder of liquid, creating a partial pore filling, introduces a new contribution to the heat capacity. This is thought to be due to the formation of a free surface, the extra contribution arising from the specific heat of surface modes. (M.H.R.)

18590 IMPURITIES IN LIQUID HELIUM. Gross, E. P. (Brandeis Univ., Waltham, Mass.). pp 275-304 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The structure and behavior of the following entities in liquid helium are described: neutral ^{3}He, positive ions, negative ions, and macroscopic objects. An attempt is made to view the impurities from a common analytic framework. The correspondence between the behavior of impurities in liquid helium and polaron theory is stressed, using the semi-phenomenological hydrodynamic model as a bridge. Topics covered are: energy functionals — instantaneous vs self-trapping wave functions, the phenomenological model, the Bose fluid in a fixed potential, the bubble model without polarization, the polarization interaction, and the relation to microscopic theory — improved wave functions. (M.H.R.)

18591 VORTICITY IN LIQUID HELIUM STUDIED BY THE ION TECHNIQUE. Careri, G.; Dupre, F.; Mazzoldi, P. (Univ., Rome). pp 305-27 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Different aspects of the interaction of ions and vorticity in liquid helium are analyzed. The slow-ion technique has proved to be able to detect vorticity in the same large-scale phenomena as the technique of second sound (for instance in rotating helium), and can also be applied to investigate only the superfluid motion. Hot ions, on the other hand, couple to vortex lines and make possible a quantitative study of the elementary properties of vortices. The interaction of the ions with the vorticity is a problem for further investigation. (M.H.R.)

18592 VORTEX FORMATION BY A MOVING ION. Pines, D. (Univ. of Illinois, Urbana). pp 328-31 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

An attempt to calculate the critical velocity for the production of vortex rings by a moving ion is described. This calculation led to a critical velocity of 73 m/sec, which is somewhat high. (M.H.R.)

18593 CREATION OF QUANTIZED VORTEX RINGS BY IONS IN LIQUID HELIUM. Huang, Kerson (Massachusetts Inst. of Tech., Cambridge). pp 332-6 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

On the basis of a previously proposed model, an explanation is given for the heat flush experiment. Discontinuities in the average mobility are discussed in relation to this model. An experiment is proposed to test the basic hypothesis of this model. (M.H.R.)

18594 THEORISTS' VIEW OF QUANTUM FLUIDS. Pines, David (Univ. of Illinois, Urbana). pp 338-44 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The theoretical views presented at the conference are summarized under the following topics: the common features of superfluid behavior, some differences between helium(II) and superconductors, liquid ^{3}He, and open problems. (M.H.R.)

18595 EXPERIMENTALIST'S SURVEY OF LIQUID HELIUM. Reif, F. (Univ. of California, Berkeley). pp 345-52 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

Experimental work on the properties of liquid helium and on some of the similarities between superfluid helium and superconductors is reviewed. Topics covered are: macroscopic quantization, macroscopic phase effects, quantized vortex lines, vortices and ions, neutron scattering by liquid helium, liquid ^{3}He, and the attainment of very low temperatures. (M.H.R.)

18596 EXPERIMENTALIST'S VIEW OF SUPERCONDUCTIVITY. Tinkham, M. (Univ. of California, Berkeley). pp 353-7 of Quantum Fluids. Brewer, D. F. (ed.). New York, John Wiley and Sons, Inc., 1966.

The experimental advances reported at the symposium are reviewed. Some of these were: demonstrating the reality of fluxoid quantization in units of $\varphi_0 = hc/2e$, experiments on noise measurements, and work on the magnetization process in thin wires. Other topics covered were: the motion of vortices in the presence of a transport current, the observation of resistance and Hall effect in superconductors, how flux lines enter the superconductor over a surface barrier, and superposed thin layers of superconducting and normal metals. (M.H.R.)

18597 PAIR DISTRIBUTION FUNCTION OF A DILUTE HARD-SPHERE BOSE GAS. Bhattacharya, Manju Gopal. Buffalo, State Univ. of New York, 1966. 73p.

Thesis.

Ever since Feynman showed that the peculiar properties of liquid helium can be determined from its energy spectrum which, in turn, can be obtained from the pair distribution function, efforts have been made to evaluate the energy spectrum of a hard-sphere Bose gas which serves as a simplified model for liquid helium. Determination of the pair distribution function is important in this connection. Various thermodynamic properties of a system can also be derived from it. In this investigation Lee and Yang's quantum statistical theory of the grand partition function was used to evaluate the correction terms arising from the various higher-order interactions among the molecules to the pair distribution function of an ideal Bose gas. Lee and Yang's theory consists of the expansion of the grand partition function in terms of Uhlenbeck and de Boer's U functions. These U functions are then essentially expanded in powers of the binary kernel which is obtainable from a solution of the two-body problem. These results improve upon those of Colin and Peretti who considered only the first-order interactions, of Fujita and Hirota who evaluated the correction terms to the pair distribution function arising from only the chain diagrams, and finally, of Isihara and Yee who considered the chain and the tick-tack-toe diagrams. These results are based on new infinite sets of diagrams as two limiting cases. The contributions of these hybrid diagrams to the pair distribution function was evaluated. Preliminary discussions of more complex diagrams are given. (Dissertation Abstr.)

18598 HEAT TRANSFER TO SATURATED AND SUBCOOLED BATHS OF LIQUID HELIUM II. Madsen, Richard Alfred. Lafayette, Ind., Purdue Univ., 1965. 148p.

Thesis.

The heat transfer was measured from horizontal cylinders, approximately 1.8 mm in diameter and 3 cm long, to baths of liquid helium(II) at 1.96 and 2.10°K, for temperature differences between the surface of the cylinder and the baths of 0.01 to 150°K. Both the saturated condition and a subcooled condition with a pressure of 775-mm Hg were investigated. Three regimes of heat transfer were observed: two in nonboiling and one in film boiling. No nucleate boiling was observed. Superheats of 2 to 6°K were observed prior to transition to film boiling. The transition took place with a jump in temperature of approximately 35°K. (Dissertation Abstr.)

18599 THERMAL EXPANSION IN QUANTUM LIQUIDS. Boghosian, Charles. Durham, N. C., Duke Univ., 1966. 140p.

Thesis.

The dielectric constant of liquid helium was measured and use made of the Clausius–Mossotti relation to determine the density as a function of temperature and pressure. The procedure used was that of measurement of the resonant frequency of the tank circuit of a tunnel diode oscillator operating at liquid helium temperature, the capacitor of which contained the liquid helium sample under pressure. The range of measurement was 0.07 to 1.2°K and 0 to 28 atmospheres for ^{3}He and 0.55 to 1.4°K and 0 to 25 atmospheres for ^{4}He. The measurements were made at constant pressures which were known to better than 0.1 mm for pressures below 1 atmosphere and 0.5 psi for higher pressures and kept constant to within approximately 3 parts in 10^5. The coefficient of thermal expansion at constant pressure was determined by graphical differentiation of the density vs temperature curves. The entropy of compression was determined by numerical integration of the expansion coefficient with respect to pressure. The change in compressibility was calculated from 1.2 and 1.25°K for ^{3}He and ^{4}He, respectively, down to the low-temperature

limit of measurement of each of these isotopes. From the entropy of compression the roton energy gap of the Landau theory for ^{4}He was determined as a function of pressure for temperatures below 1.3°K. The expansion coefficient of ^{3}He is zero for T = 0.5°K at zero pressure and for T = 1.2°K at 28 atmospheres, being positive above and negative below these temperatures. A minimum in the expansion coefficient is present in the neighborhood of 0.12°K at all pressures which compares qualitatively with the previous determinations. All constant pressure curves then approach zero as the temperature is lowered toward absolute zero as required by the Nernst theorem. The highest pressure values are slightly larger in magnitude than the results of Anderson, Reese and Wheatley (1963) although there is agreement within the combined errors. The zero-pressure extrapolation agrees very well above 0.5°K with the saturated vapor pressure results of Kerr and Taylor (1962). The expansion coefficient of ^{4}He is positive below about 1.14°K at zero pressure which is most nearly in agreement with the saturated vapor pressure results of Atkins and Edwards (1955). The temperature at which the expansion coefficient becomes positive decreases to about 0.59°K at 25 atmospheres in agreement with the results of Mills and Sydoriak (1965). This positive expansion coefficient at low temperatures is characteristic of the phonons of the Landau theory. The influence of the negative expansion rotons of the Landau theory is in evidence above these temperatures at all pressures up to the high temperature limit of the measurements where the expansion coefficient is becoming increasingly negative. The energy gap calculated for the rotons decreases from about Δ/k = 8.9°K at zero pressure to about Δk = 6.9°K at 25 atmospheres. These results compare very well with the results from fountain effect studies under pressure and are within 5% of the directly determined values of the energy gap by neutron scattering experiments. Tabulations are provided of all the calculated quantities at standard pressures throughout the temperature range of measurements. These results have also been presented graphically where they are compared wherever possible, with the results of previous research. (Dissertation Abstr.)

18600 THEORY OF THE [NORMAL] GROUND STATE OF LIQUID HELIUM THREE. Woo, Chia-wei. St. Louis, Washington Univ., 1966. 166p.

Thesis.

The ground state and low excited states of liquid ^{3}He can be constructed from a set of correlated basis functions $\psi(|\vec{n}) = \psi_0^S \Phi(|\vec{n})$ in which ψ_0^S is the ground-state boson-type solution of the Schroedinger equation and the model functions $\Phi(|\vec{n})$ are Slater determinants suitable for describing states of the noninteracting fermion system. Diagonal and nondiagonal matrix elements of the identity and the Hamiltonian operator are evaluated by a cluster expansion technique. The Löwdin Transformation is investigated as a method of orthogonalizing the correlated basis. Several theorems concerning its convergence properties are proposed. For a practical computation of ground state properties (energy, density, compressibility, velocity of sound, magnetic susceptibility, and radial distribution function), it is however more convenient to adapt the Rayleigh–Schroedinger perturbation theory directly to the nonorthogonal basis. Several ways of classifying and subclassifying terms in the perturbation series are critically compared; one is found to be most suitable for studying liquid ^{3}He. Numerical results are obtained in the second order of this classification scheme and compared to those of the Brueckner–Gammel theory and to experiment. (Dissertation Abstr.)

18601 IRREVERSIBLE MAGNETIZATION IN SUPERCONDUCTORS. Birchak, James Robert. Houston, Tex., Rice Univ., 1966. 112p.

Thesis.

Irreversible magnetization of superconductors refers to the hysteresis on a graph of magnetization vs applied field at constant temperature. Experimentally, magnetization measurements were made for superconducting ellipsoids, which were moved between two search coils to give a deflection in a calibrated galvanometer. The apparatus was designed to have the capability of both high precision and good sensitivity because the hysteresis was often quite small. The ellipsoids were either spheres or had major axis 3 cm and minor axis 0.635 cm. They were made of tin, lead, or niobium and were studied at temperatures between 1.5 and 4.2°K. Three sources of hysteresis were identified. There is the necessity of nucleation centers evidenced by magnetic "super-cooling," there are inhomogeneities throughout the body of the material, and there are geometric effects due to microscopic surface irregularities. "Supercooling" gave hysteresis only near the critical field of type-I superconductors and did not have any influence below the "supercooling" transition. For type-I superconductors, the hysteresis due to inhomogeneities was treated by a modified version of the sponge model. When the trapped flux had the same temperature dependence as the critical current density, the behavior could be described by a sponge structure that did not change with temperature. However, to account for all hysteresis it was necessary to assume that there were stability conditions that allowed the structure of the sponge mesh to vary with temperature. These conditions seem to explain the increased hysteresis observed near T_c for tin. They also seem to account for the behavior of one lead sample that had a small magnetization for fields above H_c only when the temperature was below 3.6°K. Niobium's hysteresis due to inhomogeneities was treated with a model using the strength of pinning forces. Measurements showed that hysteresis that followed the predictions for strong pinning centers had a temperature dependence similar to that of H_{c2}. A sample that followed the predictions for weak pinning centers had trapped flux that increased almost exponentially as the temperature was reduced. The most sensitive measurements showed that there was hysteresis for lead and niobium when the applied field was cycled between $+H_{max}$ and $-H_{max}$ even if H_{max} was so small that the samples never entered the intermediate or mixed state. This hysteresis had a temperature dependence different from that of the hysteresis arising from inhomogeneous. The trapping was attributed to surface irregularities, and a model based on geometric effects predicted the observed temperature dependence. (Dissertation Abstr.)

18602 FLUX MOTION IN HIGH-FIELD TYPE-II SUPERCONDUCTING CYLINDERS. Kroeger, Donald Moseley. Nashville, Vanderbilt Univ., 1966. 66p.

Thesis.

The behavior of hollow, thick-walled (3.2 mm), type-II superconducting cylinders in approximately linearly increasing, longitudinal, magnetic fields was investigated. The range of dH/dt employed was from 10^4 to 5×10^5 Oe/sec. The results obtained were found to depend in a fundamental way upon the heat treatment of the sample, and therefore upon its defect content. The data obtained for annealed samples are interpreted on the basis of viscous motion of flux. A measurement of the viscosity coefficient η is obtained directly from the observation of the retardation of flux motion. For a Nb–25Zr sample which had been precipitated to increase flux pinning forces, flux penetration to the interior occurred by means of flux jumps for the full range of dH/dt employed. The value of applied field H_θ at which a flux jump occurred was found to be independent of dH/dt. No flux jumping was observed in Nb–25Zr and Nb–25Ti samples which had been annealed to reduce flux pinning forces. The response of a search coil on the surface of the sample indicated that flux penetration was smooth and regular. From the response of this search coil the time of field penetration of the outside surface could be determined, and the response of a search coil inside the sample hole gave the time of flux penetration to the inside wall. In this way the average velocity of the flux front was measured. This average velocity was found to depend linearly on H_θ, the applied field at the time of flux penetration to the inner wall, and in a more complicated fashion on dH/dt. These results are satisfactorily accounted for by a simple calculation based on the viscous flow of flux vortices under the influence of the Lorentz force. (Dissertation Abstr.)

18603 AN INVESTIGATION OF IRREVERSIBLE TYPE-II SUPERCONDUCTING TRANSITIONS OF VANADIUM–IRON ALLOYS. Barkeley, John R. Athens, Ohio, Ohio Univ., 1966. 109p.

Thesis.

A model is developed for the magnetization of an irreversible type-II superconducting transition. This model is then used to describe quantitatively extensive magnetization data taken on rod-shaped samples of vanadium and vanadium–iron alloys in increasing fields. The model is based on the work of Kim and Anderson, who showed that critical body currents develop according to the equation $J_c = \alpha/(B_T + B_\theta)$ when the movement of the fluxons of the mixed state is opposed by the pinning force density α, while in the presence of a local field intensity B_T. The physical significance of the empirical constant B_θ was not understood, but was necessary to describe the data taken by Kim. The present work extends the model of Kim and Anderson to include the equilibrium magnetization; i.e., the magnetization of the sample if the unimpeded movement of the fluxons were possible. The equilibrium magnetization (M_e) is introduced in the following way. The expression for M_e is assumed to be $4\pi M_e = -4\pi M_\theta + S(H_T - H_{f_p})$, where H_{f_p} is the applied field strength (H_a) at which flux first penetrates the sample and $H_T(r)$ is the local magnetizing force, a function of position (r) in the sample. $H_T(r) = H_a + H_J(r)$, where H_J is the local, internal field produced by the Kim–Anderson critical currents $J_c - M_\theta$ is the value of M_e when $H_T = H_{f_p}$, and S is the slope of M_e as a function of H_T. An expression is developed to describe the total magnetization of a solid cylindrical sample and is compared with over 80 measured curves. (Dissertation Abstr.)

18604 X-RAY K-ABSORPTION FINE STRUCTURE OF NIOBIUM AND COPPER AT CRYOGENIC TEMPERATURES. Boster, Thomas Arthur. Athens, Ohio, Ohio Univ., 1966. 77p.

Thesis.

The x-ray K-absorption fine structure of niobium and copper was investigated at 300°, 77°, and 4.2°K to determine the fundamental dependence of fine structure temperature variations on the Debye temperature and location of scattering potentials according to the recent theories of Kozlenkov and Shmidt applied at low temperature. In addition, the fine structure of niobium was analyzed to determine any plasmon oscillation energy shifts when the niobium is in a superconducting state. Niobium was chosen because it has a high superconducting transition temperature of 9.2°K and a low Debye temperature of 252°K. Copper was chosen because it is the basic metal used in most theoretical studies of x-ray fine structure and because it has a relatively high Debye temperature of 399°K. (Dissertation Abstr.)

18605 INVESTIGATION OF NOISE IN SUPERCONDUCTING FILMS. Johnson, Arlen Kent. Hoboken, N. J., Stevens Inst. of Tech., 1966. 178p.

Thesis.

The noise characteristics of the cryotron when used as a linear amplifier form the basis of the thesis. A large contribution to the cryotron amplifier noise is traced to bubbling of the liquid helium in physical contact with the cryotron. The noise results from the bubbling of the liquid because of certain steps or discontinuities which occur in the transition region of tin films. The bubbling at the surface of the film causes it to "switch" between the steps or discontinuities in a random fashion. The result is the above mentioned noise. The noise was eliminated by isolating the thin films and cryotrons from physical contact with the liquid helium. This isolation was accomplished by enclosing the substrates on which the films and cryotrons are deposited in tightly sealed aluminum foil bags. The steps that occur in the transition region were studied and evidence is presented to indicate that they are caused by the movement of domain boundaries as they break away from pinning centers within the film. These steps can be eliminated in very thin films by using a magnetic field perpendicular to the film to control the transition. However, in magnetic fields parallel to the film, the steps are present even in these very thin films. (Dissertation Abstr.)

18606 SUPERCONDUCTING CABLE. Laverick, Charles; Foss, Martyn H.; Lobell, George M. (to U. S. Atomic Energy Commission). U. S. Patent 3,306,972. Feb. 28, 1967.

A plurality of superconductors are spatially mounted with respect to each other and a coating is disposed about the superconductors to form a superconducting cable. The coating has high thermal and electrical conductivity at liquid He temperatures. (auth)

18607 LOW TEMPERATURE ELASTIC DEFORMATION AND THE RESISTIVE PROPERTIES OF SOME SOFT SUPERCONDUCTORS. Schenck, John Frederic. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 111p.

Thesis.

Several soft superconducting metals have been plastically deformed by tensile strain at liquid-helium temperatures, and the effect of this strain on the resistive properties has been measured. In the pure metals lead, indium, and thallium strains of about 15 per cent increased the normal-state resistivity by several hundred per cent. The effect of annealing on this strain-induced resistivity increment is reported. Earlier reports that plastic deformation leads to a broadened resistive transition in lead are confirmed. However, strained indium and thallium showed no trace of such an effect. Alloys of indium with a few per cent of lead did display broadened transitions when strained. In lead the strain-induced transition width anneals in the same fashion as the strain-induced resistivity increment. A model accounting for the observed behavior and based on the Ginzburg–Landau theory is proposed. It is proposed that the deformed metals contain regions of high dislocation density and the large amount of electron scattering in these regions leads to an increase of the Ginzburg–Landau parameter, kappa, above its value in the bulk of the metal. This results in a local increase in the critical field H_{c2} (and in H_{c3} for dislocation clusters near the sample's surface). In this model type-I materials will display a broadened transition when the local value of one of these fields exceeds the bulk critical field, H_{cb}. Therefore, type-I materials whose intrinsic kappa is relatively large will be most likely to show a strain-induced transition width. In type-II materials local variations in H_{c2} and H_{c3} will always result in some change in the resistive transition. It is also shown that a position-dependent kappa can also account, in a qualitative fashion, for the peak effect in inhomogeneous type-II materials. (Dissertation Abstr.)

18608 ULTRASONIC STUDIES IN NORMAL AND SUPERCONDUCTING THALLIUM. Weil, Raoul B. Riverside, Calif., Univ. of California, 1966. 116p.

Thesis.

Ultrasonic attenuation and velocity measurements have been made on single crystals of 99.999% pure thallium. These measurements have been made using the double ended pulse-echo technique in the range of 12 to 108 Mc. One of the results of the study is to verify Pippard's phenomenological equation for the attenuation of sound waves by normal electrons. The five adiabatic elastic constants of hexagonal Tl have been calculated from the velocity of 12-Mc sound pulses. c_{11}, c_{33}, c_{44}, c_{12}, c_{13} are found to be 4.19, 5.49, 0.720, 3.66, 2.99 and 4.53, 6.11, 0.903, 3.86, 2.92, respectively at 297°K and 4.2°K; the units are 10^{11} dynes/cm^2, and the probable accuracy is ±1%, except for c_{13} where it is ±4%. From these elastic constants, the Debye temperature is found to be 83.2°K at 4.2°K, and the isothermal compressibility 2.92×10^{-12} cm^2/dyne ± 1.5%, at 297°K. It is shown that the elastic constants do not account for the anomalous stress dependence of the critical magnetic field of Tl. It is also shown that the magnitude of the elastic constants cannot be accounted for by changes in the electrostatic energy alone. The superconducting transition temperature of the Tl specimens is found to be 2.378 ± 0.008°K. The curves of shear wave attenuation in the superconducting state, as a function of temperature, do not exhibit a discontinuous drop at T_c because the mean free path is short. The superconducting energy gap at 0°K is obtained from these curves using the assumption that the temperature dependence of the gap predicted by the BCS theory holds. The values found for the gaps are: $2\Delta/k_BT_c$ = 3.7 ± 0.1, 3.75 ± 0.1, 3.9 ± 0.1 for the propagation and polarization directions [0001][10$\bar{1}$0], [10$\bar{1}$0][0001], and [10$\bar{1}$0][1$\bar{2}$10] respectively. These measurements have been made at 60 Mc. Measurements at other frequencies in the range of 12 to 108 Mc reveal no frequency dependence of the gap or of its anisotropy. A strain-amplitude dependence of the attenuation is found both in the normal and superconducting states. (TSS)

18609 QUANTIZED VORTICES IN THIN SUPERCONDUCTORS. Mochel, Jack McKinney. Rochester, N. Y., Univ. of Rochester, 1966. 156p.

Thesis.

The previously unknown state of a thin superconducting film in a perpendicular magnetic field was investigated by a variety of experiments. The development of techniques for making thin film microgeometries, with typical dimensions of one micron, made possible experiments which provided proof of the existence of quantized vortices in superconducting films. The size (area) of a vortex, at temperatures just below the transition temperature T_c, was found to be equal to the value of the flux quantum ($hc/2e$ = 2.07×10^{-7} gauss-cm^2) divided by the value of the applied magnetic field. The microgeometries, in the presence of high current densities, displayed a unique "inverse" magnetic hysteresis never before observed in superconductors. Current densities higher than ever reported were obtained both in normal metal, using silver microgeometries, and in superconductors, using tin microgeometries. Measurements of the thermal conductivity of multiply connected microgeometries revealed flux quantization. Measurements of the thermal conductivity of simply connected microgeometries produced preliminary results which suggest that this is potentially a powerful technique for studying the properties of quantized vortices in thin superconductors at temperatures well below T_c. (Dissertation Abstr.)

18610 HELIUM FILM TRANSFER 0.4°K TO THE λ POINT. Harris-Lowe, Rodney Frederic Brandon. Columbus, Ohio, Ohio State Univ., 1966. 132p.

Thesis.

The helium film transfer rate on glass was measured over the range 0.4°K to the lambda point in clean, isothermal conditions. Previous measurements of the rate below 1°K showed an unexpected increase in the transfer rate, but they were subject to criticisms arising from the possibility of contamination of transfer surfaces and a lack of temperature control while measurements were being taken. The preliminary measurements corresponded to accepted values above 1°K and confirmed the increase in transfer rate below this temperature. The scatter of results exceeded that expected from an analysis of experimental errors. In order to determine the source of scatter, the transfer process was studied in detail at six well-regulated temperatures (±.005°K). This examination led to the conclusion that the phenomenon was basically not reproducible. However, it also revealed that during film transfer from the glass beaker the rate did not decay continuously with increasing film height (or decreasing level difference) but instead generally decayed in a sequence of small (~5%) sharp transitions. On a few occasions large (~20%) transitions were observed. Between these transitions the rate was constant to within experimental error. There was sufficient difference in the values

of the constant rates which occurred over given segments of the beaker, and in the positions of the rate transitions, to rule out the possibility that these effects were due to some peculiar variation of the beaker substrate. Some evidence indicated that the same effects might be present during beaker fillings. The distribution of the constant rates between transitions showed that at each temperature they tended to group about a set of equally spaced, "preferred" values. The spacing between preferred rates ($\sim 0.6 \times 10^{-5}$ cm^2 sec^{-1}) was apparently insensitive to temperature changes below 1°K but decreased slightly at higher temperatures. Some theoretical speculations are presented which show that an extension of the present theory of critical velocities arising from the production of quantized vortex lines might account for these observations and for other observed characteristics of film transport. (Dissertation Abstr.)

18611 CURRENT DEPENDENCE OF THE ENERGY GAP IN SUPERCONDUCTORS: A DIRECT MEASUREMENT. Mitescu, Catalin Dan. Pasadena, Calif., California Inst. of Tech., 1966. 65p.

Thesis.

From the tunnelling characteristics of a tin/tin oxide/lead junction, a direct measurement was made of the energy-gap variation for a superconductor carrying a current in a compensated geometry. Throughout the region investigated—several temperatures near T_c and down to a reduced temperature $t = 0.8$—the observed current dependence agrees quite well with predictions based on the Ginzburg–Landau–Gorkov theory. Near T_c the predicted temperature dependence is also well verified, though deviations are observed at lower temperatures; even for the latter, the data are internally consistent with the temperature dependence of the experimental critical current. At the lowest temperature investigated, $t = 0.8$, a small "Josephson" tunnelling current allowed further a direct measurement of the electron drift velocity at low current densities. From this, a preliminary experimental value of the critical velocity, believed to be the first reported, can be inferred on the basis of Ginzburg–Landau theory. For tin at $t = 0.8$ $v_c = 87$ m/sec was found. This value does not appear fully consistent with those predicted by recent theories for superconductors with short electronic mean free paths. (Dissertation Abstr.)

18612 IMPROVEMENTS IN OR RELATING TO COMPOSITE SUPERCONDUCTIVE WIRE. Williams, John Eric Charles Watts (to United Kingdom Atomic Energy Authority). British Patent 1,061,927. Mar. 15, 1967. Filed Sept. 7, 1962.

A method of making a composite superconductive wire is described. This method provides a plurality of lengths of a material which is superconducting at the temperature at which the wire is to be used. These lengths are to be used within a carrier material which is not superconducting at said temperature. The cross-sectional area of the carrier material and the included superconductive material is to be reduced by swaging and/or drawing to form a wire. This reduction is to be continued until the superconductive material is reduced to filaments of small enough diameter to exhibit superconductivity in a magnetic field in excess of the critical magnetic field for that material. (M.H.R.)

Plasma and Thermonuclear Physics

Refer also to abstracts 17582 and 18268.

18613 (AED-C-03-04) DOCUMENTATION OF PLASMA PHYSICS. PART 1. EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. BIBLIOGRAPHY, AUTHOR INDEX, SUBJECT INDEX. Volume 2. Hilsenbeck, D. (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Jan. 1967. 152p. Dep. mn.

A listing is presented of 406 papers dealing with all aspects of plasma research. In addition, subject and author indexes are also included. (M.O.W.)

18614 (MATT-1(6th Ed.)) CUMULATIVE LISTING OF PLASMA PHYSICS LABORATORY REPORTS AND PUBLICATIONS (6TH EDITION). (Princeton Univ., N. J. Plasma Physics Lab.). Feb. 1967. Contract AT(30-1)-1238. 33p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A cumulative listing is presented of reports and publications issued by the Princeton University Plasma Physics Laboratory from its inception in July 1951 (under the name Project Matterhorn) to date. (M.O.W.)

18615 (AD-645818) LECTURES ON PLASMA PHYSICS. Sinel'nikov, K. D.; Rutkevich, B. Translated from pp 1-241 of Lektsii po Fizike Plazmy, Kharkov, 1964. 318p. (FTD-TT-65-1565). CFSTI $3.00 cy, $0.65 mn.

Fundamentals are presented of the physics of a plasma in which thermonuclear reactions may be effected under certain conditions. Descriptions are presented of the interaction between the plasma particles, the motion of the plasma in electric and magnetic fields, various methods of experimental investigation and theoretical treatment of a plasma, and also the difficulties arising in the formation of a high-temperature plasma are discussed. (M.O.W.)

18616 HYDROMAGNETIC EQUILIBRIUM AND STABILITY. Greene, John M.; Johnson, John L. (Princeton Univ., N. J.). pp 195-244 of Advances in Theoretical Physics. Vol. I. Brueckner, Keith A. (ed.). New York, Academic Press, 1965.

General problems of hydrodynamics are discussed. The areas of equilibria and stability are reviewed with respect to magnetic field theory. (M.O.W.)

18617 BASIC DATA OF PLASMA PHYSICS, 1966. Second Edition, Revised. Brown, Sanborn C. Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 318p. $8.00.

Data of interest in plasma research are given on elastic-collision cross sections, charge-transfer cross sections, mobility and diffusion, inelastic collisions of electrons, electron attachment and electron detachment, and recombination. (M.O.W.)

18618 DOCUMENTATION OF PLASMA PHYSICS. PART I. EXPERIMENTAL PLASMA PHYSICS, THEORETICAL PLASMA PHYSICS. VOLUME 2. Hilsenbeck, D. Garching, Ger., Institut fuer Plasmaphysik, 1967. 154p.

A listing is presented of 406 papers on various aspects of plasma physics. Subject and author indexes are also included. (M.O.W.)

Confinement and Heating of Plasma

Refer also to abstracts 17754 and 18641.

18619 (IPP-1/57) VAKUUM-MAGNETFELD IM THETA-PINCH: VERMEIDUNG VON ASYMMETRIEN. (Elimination of Asymmetries in the Vacuum Magnetic Field of Theta Pinch Coils). Pohl, Frank (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Jan. 1967. 26p. (In German). Dep. mn.

Deviations from rotational symmetry of the magnetic field in theta pinch coils are always due to the fact that the current does not flow vertically from the adapter to the coil, if the end planes are assumed to be infinitely small. By means of numerical calculations it is shown that: (1) The influence of the current feed can largely be eliminated by making the adapter sufficiently long in the direction perpendicular to the coil axis. (2) The current at the coil ends can be made to flow almost perpendicularly to the slot by extending the adapter in the axial direction about half a coil radius larger than the coil itself. (3) It is also possible in corrugated (Limpus) coils to make the current flow perpendicularly to the slot by including inductive lenses in the adapter. (auth)

18620 (NP-16612) DIAMAGNETIC PLASMA INJECTION INTO A MAGNETIC CUSP. Rijnhuizen Report 66-34. Ornstein, L. Th. M.; Hugenholtz, C. A. J.; van der Laan, H. A. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Aug. 1966. 14p. Dep. mn.

The piercing of the equatorial barrier of a cusped magnetic field by a cylindrical plasmoid is studied. The plasmoid is produced as a short linear pinch discharge, either of a hollow type or of the snowplow type. Completely diamagnetic piercing is only found if a snowplow pinch in hydrogen gas is used; apparently, in this case, the electron temperature is sufficiently high to exclude the field from the plasma during the flow. At a maximum field strength in the barrier of 3.85 kG, piercing is just possible if the plasma density is 8×10^{15} cm^{-3} at a flow velocity of 9×10^6 cm/sec. The confinement time of the plasma in the central region of the cusp is limited to 4.5 μsec by dissipative mixing of plasma and magnetic field. (auth)

18621 (NP-16634) STOKHASTICHESKOE RAZRUSHENIE MAGNITNYKH POVERKHNOSTEI STELLARATORA. (Stochastic Destruction of Stellarator Magnetic Surfaces). Chirikov, B. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 20p. (In Russian). Dep. mn.

Some estimates about the stability of the lines of force for a stellarator magnetic field against static perturbations are given. It is shown that increasing of the derivative $d\omega/dz$ (ω is mean rotation speed of the magnetic line at distance z from stellarator's axis around the axis) results in increasing of line stability against resonance perturbations only up to a certain limit. Above that a new so-called stochastic instability may occur. Stochastic instability can be used to realize the so-called Scornyakov's trap which has inside a certain "turbulent" (in respect to "motion" of the magnetic lines) or stochastic region surrounded by "laminar" layer of "proper" magnetic surfaces. Such a structure can be

achieved by additional resonance helical winding which period is equal to the revolution period of the magnetic line in the stochastic region. One may expect the suppression of plasma instabilities in the stochastic region by means of additional damping due to the "diffusion" of magnetic lines. (auth)

18622 (UCID-15067) NOTE ON THE STABILITY OF THE E-LAYER. Christofilos, N. C. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 16, 1967. Contract W-7405-eng-48. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Calculations are given that indicate that the value of the destabilizing term in the dispersion relation remains constant during E-layer buildup. The calculations were carried out for a pure azimuthal mode where the operator $(1 - \overline{vv})$ is proportional to the azimuthal velocity spread v_θ. The value of this operator operating at other field components is larger and not proportional to v_θ. Consequently, in other modes, the destabilizing term is proportional to n_e/v_θ^2, thus decreasing with increasing loading factor. (M.O.W.)

18623 OBSERVATION OF ION HEATING USING A MODULATED ELECTRON BEAM IN A MAGNETIC MIRROR FIELD. Haas, G. M.; Dandl, R. A. (Oak Ridge National Lab., Tenn.). Phys. Fluids, 10: 678-80(Mar. 1967). (ORNL-P-2678).

The interaction of a modulated electron beam of modest current with a plasma formed in a hydrogen gas produces protons with energies up to several hundred electron volts. The energetic proton flux from the plasma is dependent on the beam current and modulation frequency. (auth)

18624 PRODUCTION OF HIGH PULSED CURRENTS THROUGH EXPERIMENTS ON CONTROLLED THERMONUCLEAR FUSION. Toschi, R. (CNEN, Rome). Elettrotechnica, 53: 647-61(1966). (In Italian).

Sources for experiments on controlled thermonuclear fusion are studied; the characteristics of condensers, inductors, rotating machines, batteries, and explosives are considered. The nature of an installation for production of impulse currents at the Laboratori Gas Ionizzati is outlined: the circuit for the fast magnetic field and that for the initial magnetic field, the condenser bank, the transformer, block inductors, the tower, and the high-tension and short-circuit interrupters are described in detail and illustrated. Several equations relating to the properties of the interrupters, transfer yield, the equivalent dielectric constant of the generator, and the energy furnished by the banks are derived in an appendix. (BBB)

18625 SOME ASPECTS OF CLASSICAL DIFFUSION. Bineau, Michel (New York Univ.). Phys. Fluids, 10: 672-3(Mar. 1967).

The rate of resistive diffusion is computed using an expansion near the magnetic axis of a hydromagnetic equilibrium under the hypothesis of a steady state. A different limiting case is mentioned for comparison. (auth)

18626 SMALL ROTATIONAL TRANSFORMS. Lindner, J.; Lortz, D. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Fluids, 10: 630-1(Mar. 1967).

If a solenoidal field B can be separated into a fundamental component B_0 with closed field lines and a perturbation B_1 of the order ϵ, it is possible to integrate the differential equations for the field lines up to the second order in ϵ. It turns out that the rotational transform is of the order ϵ if the flux of the field B_1 through a surface limited by any closed field line of B_0 does not vanish. When the transform is of the order ϵ^2 one can derive an explicit expression for the magnetic surfaces. (auth)

18627 SHEAR ATTAINABLE IN STELLARATOR SYSTEMS. Bickerton, R. J.; Gibson, A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Phys. Fluids, 10: 682-3(Mar. 1967).

An estimate is made of the maximum shear attainable in a toroidal l = 3 stellarator. The loss of plasma due to universal instabilities in such a sheared system is compared with the Bohm loss rate. The maximum shear is compared with that obtained in other toroidal systems. (auth)

18628 INVESTIGATION OF PLASMA IN A MAGNETIC TRAP HAVING OPPOSED MAGNETIC FIELDS. Kovalskii, N. G.; Sumarokov, V. N. Zh. Tekh. Fiz., 36: 1976-83(Nov. 1966). (In Russian).

The behavior of plasma in a trap having opposed fields was studied for a case of when the typical time period for collision processes in (ion–ion Coulomb collisions and proton charge exchanges by neutral hydrogen atoms) is only a few milliseconds. A plasma bunch was injected into the trap through a ring diaphragm set on the axis of the system in the region of the magnetic gap. The velocity of the bunch was 1 to 2×10^9 cm/sec, and the total energy of the plasma injected into the trap was 0.3 j. Experiments showed that at the initial moment the plasma fills the central region of the trap near the point of zero magnetic field intensity. At a field intensity of 3000 Oe, the concentration of plasma was $\sim 3 \times 10^{11}$ cm^{-3}. As a result of special efforts the concentration of impurity atoms and neutral hydrogen in the chamber did not exceed 5×10^9 cm^{-3}. It is shown that protons leave the trap in the region of the magnetic ring gap with an average transverse energy of ~50 eV. This demonstrates the effectiveness of the conversion of directed plasma bunch energy into a Larmor-ion rotation in interaction with opposed magnetic fields. The containment time of particles with a given average energy exceeds by one order the time of flight through the region affected by the magnetic field. Plasma lifetime was found to be strongly affected by the intensity of the magnetic field. (ATD)

18629 CONCERNING ANOMALIES IN THE ESCAPE OF DENSE PLASMA FROM A MAGNETIC MIRROR SYSTEM OWING TO THE PRESENCE OF THE LOSS CONE. Galeev, A. A. Zh. Tekh. Fiz., 36: 1959-63(Nov. 1966). (In Russian).

A discussion is presented on the instability of a dense plasma in a magnetic mirror system due to the anisotropy of the ion velocity distribution and the presence in that distribution of a "loss cone." The discussion is limited to the case of a short system, whose length is less than $10^4 D(1 + (f/F)^2)^{1/2}$, where D is the Debye radius, f is the electron Langmuir frequency, and F is the ion Larmor frequency. The approximately quantitative portion of the discussion is based on the dispersion equation of E. G. Harris, as generalized to the case of a nonuniform plasma with different transverse and longitudinal temperatures by V. I. Pistupnovich and collaborators. The assumption of Maxwell ion velocity distributions is rejected, however, and more attention is given to the stabilizing influence of the finite length of the system than Pistupnovich et al. gave. From a condition for nonlinear instability previously given by the author there is derived a series of approximate stability conditions on the length of the magnetic mirror system. These are employed to discuss some earlier experimental findings. The observed rapid decrease of plasma density at densities of the order of 5×10^9 cm^{-3} is ascribed to the development of an anisotropic instability that leads to rotation of the ion velocity vector. At that density the critical length is about 30 cm; the behavior of the plasma might nevertheless be explained by concentration of the plasma near the center of the trap. (ATD)

18630 VOLUME POLARIZATION INTERACTION OF PLASMAS IN A MULTIPOLE MAGNETIC FIELD. Zykov, V. G.; Stepanenko, I. A.; Tolok, V. T. Zh. Tekh. Fiz., 36: 1971-5 (Nov. 1966). (In Russian)

The behavior of plasma bursts with velocities of 2×10^6 cm/sec and densities of 10^{12} to 10^{13} cm^{-3} was investigated. The bursts were produced by conical plasma guns and transversely injected singly or simultaneously in opposite directions into the magnetic field produced by the inductively loaded 3-kV discharge of a 2.7-mF capacitor bank through four parallel 1-cm-diameter 150-cm-long brass rods, which formed the edges of a rectangular parallelepipedon with a cross section diagonal of 10.5 cm. The period of the loaded discharge was 4 millisec and the maximum strength of the magnetic field produced on the injection axis by the currents in the rods, all four of which were in the same direction, was 1.2 kOe. The injected plasmas were photographed and their behavior was investigated with electric and magnetic probes. It was found that a plasma burst of considerable density would pass through both magnetic barriers. From this it is concluded that simultaneous injection from opposite directions is necessary for efficient entrapment of plasma. The magnetic field configuration recorded with simultaneous injection of plasmas from opposite directions differed considerably from the algebraic sum of the fields recorded with single injection of plasmas from the two directions; this shows that the colliding plasmas interacted with each other. The moving plasmas were electrically polarized. The polarization of a singly injected plasma changed sign, but the polarization passed through zero not on the axis of the system, but some 0.5 cm beyond the axis in the direction of motion of the plasma. When two plasmas were simultaneously injected in opposite directions their polarizations decreased smoothly and vanished on the axis of the system. Plasma was entrapped in the field when two plasmas were simultaneously injected; the entrapped plasma moved both along the magnetic lines of force and parallel to the axis of the system. (ATD)

18631 INVESTIGATION OF THE MATERIAL BALANCE BETWEEN THE PLASMA FILAMENT AND THE GASEOUS SHELL IN THE TOKAMAK-3 TOROIDAL MACHINE. Gorbunov, E. P.; Kotel'nikov, Yu. N.; Kutukov, G. P.; Simonov, V. A. Zh. Tekh. Fiz., 36: 1831-41(Oct. 1966). (In Russian).

Ionization gages were used to record the pressure of the neutral gas surrounding the plasma filament during operation of the Tokamak-3 machine, and with the aid of the data thus obtained discussions are presented on the exchange of material between the plasma, the surrounding gas, and the stainless steel liner of the

toroidal discharge chamber. The electron beam of the ionization gage was modulated to make it possible to distinguish the ionization gage signal against the noise background from the main discharge. Each instrument consisted of two identical ionization gages in a single envelope; one gage of the pair was usually operated with a cold cathode and its signal was subtracted from that of the normally operated gage to reduce the noise background. Entrance of charged particles into the ionization gage was prevented by an electrostatic trap. Data were recorded under different operating conditions: the duration of the discharge was 12 or 20 millisec; the magnetic field strength ranged from 12 to 25 kOe; the initial hydrogen pressure varied from 6×10^{-5} to 4×10^{-4} torr; and the liner temperature was varied between 20 and 500°C. Some of the data are presented graphically and are discussed. With the aid of the material balance equation, a technique is developed for deriving the lifetime of an ion in the plasma from the gas pressure measurements, the usual measurements of plasma density and radius of the plasma filament, and the known or assumed cross sections for charge exchange and ionization of atoms and molecules in the plasma. The ion lifetime was found to increase with increasing magnetic field strength and to be very sensitive to other characteristics of the plasma. Investigation of these relationships is being continued. The ion lifetime was found to be somewhat less than the duration of plasma confinement under all the investigated conditions, and the plasma density was found to be about equally determined by the ion lifetime and the lifetime of an absorbed atom on the liner. (ATD)

18632 INVESTIGATION OF MOTION OF A PLASMA BURST IN NONUNIFORM TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G.; Rutkevich, B. N.; Sinel'nikov, K. D. Zh. Tekh. Fiz., 36: 1819-25(Oct. 1966). (In Russian).

A brief theoretical discussion is presented in the drift approximation of the adiabatic motion of a plasma in a nonuniform transverse magnetic field. It is shown that the plasma is decelerated on entering a region of high transverse magnetic field strength and accelerated on leaving such a region, owing to the transformation of kinetic energy of forward motion into kinetic energy of rotation and vice versa. If the magnetic field becomes strong enough, the plasma can be reflected. Plasmas were injected from a conical plasma gun through an 80-cm-long 7-cm-diameter drift tube across a transverse magnetic field of up to 0.2 weber/m^2 produced by a solenoid in a 12-cm-diameter transverse tube. The magnetic field gradient was adjusted with the aid of soft iron shields within the plasma drift tube; these shields were covered with glass tubes to prevent the plasma from coming in contact with them. The plasma gun was powered by the 15-kV discharge of a 15-μF capacitor and produced plasmas containing 70% hydrogen ions with densities of about 10^{14} cm^{-3} and velocities of about 2.5×10^4 m/sec. The theoretical linear relation between the square of the plasma velocity and the strength of the transverse magnetic field was confirmed by the experiments. Plasmas with densities as low as 10^{12} cm^{-3} were obtained with the aid of an iris mounted in the drift tube. These plasmas did not conform to the adiabatic theory, but were to a considerable extent entrapped in the transverse magnetic field, particularly when the field gradient was high. It is concluded that low-density hydrogen plasmas can be entrapped by a transverse magnetic field of considerable strength. (ATD)

18633 TOROIDAL MAGNETIC TRAP OF THE STELLARATOR TYPE WITH EXTERNAL INJECTION OF THE PLASMA. Berezhetskii, M. S.; Grebenshchikov, S. E.; Zverev, N. M.; Shpigel', I. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 20-8(1966). (In Russian).

The vacuum chamber of the magnetic trap under consideration was in the form of a torus with a diameter of 120 cm and a cross section diameter of 10 cm. A magnetic field of the stellarator type (without taking the toroidal character into account) has the following form: $\Phi = H_0 z + 1/\alpha \sum_{k=0}^{\infty} H_p I_p(p\alpha r) \sin p(\varphi - \alpha z)$, $p = n(2k + 1)$, where Φ is the scalar potential of the magnetic field; H_0 is the magnitude of the longitudinal field; H_p is the amplitude of the p-th harmonic of the helical field; r, φ, z are coordinates. There follows a mathematical development for the case of a helical field with n = 2. Detailed mechanical drawings are given of several of the main features of the equipment used, including a cross section view of the apparatus, details of the helical winding, and a block diagram of the feeding system. A further figure shows an oscillogram of the current flowing through the winding. (ATD)

18634 TRANSPORT PHENOMENA IN PLASMAS AS AN INITIAL VALUE PROBLEM. Huchital, David A. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 179p. Thesis.

A preliminary approach to the general transport problem is presented by considering the diffusion phenomenon from the moments of the Boltzmann equation. It is shown that the conventional approach fails to take into account the effects of particle inertia. Including effects results in a description of the phenomenon in terms of the Telegrapher's equation. An integral solution is obtained for arbitrary initial conditions. This solution is interpreted as implying that diffusion to an arbitrary point in space consists of particles that stream directly through the background gas and those that suffer one or more collisions in transit. The qualitative differences between this analysis and the classical approach are shown to be significant under certain circumstances. However, the macroscopic approach to diffusion as an initial value problem is examined and it is shown that while this theory represents an improvement over the classical result, it falls short of being a complete description of the phenomenon. It is shown that it is difficult to approach an initial value problem from the viewpoint of the macroscopic equations because of the problem of reducing the number of variables. A microscopic development in terms of the distribution function is presented. This approach is shown to generalize the discussion significantly to include a variety of transport phenomena, and to be more rigorous, in this case, than the macroscopic analysis. The Boltzmann equation for free diffusion is solved as an initial value problem and the macroscopic variables are obtained by integration of the result. The development of density and temperature associated with the relaxation of gradients in the initial distribution function is illustrated. It is shown that this approach allows the collision model to be generalized to include a velocity dependent collision frequency. The flow of an electronic plasma in an electric field is considered as an initial value problem and the Boltzmann equation is solved. It is shown that the initial condition propagates along the single particle orbit and that collisions with neutrals serve to remove particles from this group and deposit them in a wake in phase space. An asymptotic formula valid in the vicinity of the origin in phase space is obtained. The flow of an electronic plasma across a magnetic field is considered as an initial value problem. The collisionless Boltzmann equation is solved for the single particle orbit in phase space. A macroscopic approach is used to derive a solution for the case of a weak magnetic field. In order to discuss the case of a strong magnetic field, the microscopic approach is considered. The differential equations describing the motion are complex and an approximate solution is obtained. It is shown that the distribution function relaxes towards a form that can be described by Fick's law. The conditions under which Fick's law is an appropriate description is explored and it is shown that the terms expressing the relaxation towards Fick's law can be significant under some circumstances. (Dissertation Abstr.)

18635 PRODUCTION AND CONFINEMENT OF PLASMA. (to Siemens-Schuckertwerke AG). British Patent 1,064,047. Apr. 5, 1967. Priority date June 14, 1963, Germany.

A device for generating and confining a plasma is described. It comprises a tubular discharge vessel and means operable to produce in the vessel a succession of alternate Z- and θ-pinch discharges. This means is such that in operation an inertial confinement plane occurs between each of the discharges and the next succeeding discharge. (M.H.R.)

Diagnostics of Plasma

Refer also to abstract 17921.

18636 (ARL-66-0234) DETERMINATION OF THE VELOCITY DISTRIBUTION IN PLASMAS WITH LASERS BY THOMSON AND BY RESONANT SCATTERING. Shkarofsky, Issie P. (RCA Victor Co., Ltd., Montreal (Quebec). Research Labs.). Nov. 1966. Contract AF33(615)-2196. 74p. CFSTI $3.00 cy, $0.65 mn.

Laser scattering methods that appear promising for deducing the single-particle electron-velocity distribution (as well as density and temperature) are described and compared. Single-laser Thomson scattering with $kl_D \gg 1$ and a frequency shift greater than the plasma frequency is reviewed and shown to be feasible for the velocity range between thermal to three times thermal velocity. Also analysed are methods involving Thomson scattering off the electron plasma or ion plasma resonance with $kl_D < 1$. A new method is described, using the double-laser method of Kroll et al., to scatter off induced plasma oscillations. The detailed theory is presented for arbitrary distribution functions and with fewer assumptions than in other work. Based on Landau damping, this method is suited for the high-velocity range between 2.4 and 4 times thermal velocity, the upper limit given by collisional damping and hence dependent on density. The best density range is between 10^{12} and 10^{13}/cc. With a N_2 + CO_2 + He laser at 10.6 μ, the scattering angles are between 10° to 20°. For an appreciable scattering angle at lower densities, sources between 126 and 1450 times the plasma frequency are required when the electron temperature is 3000°K. (auth)

18637 (FTI-211/R-065) MIKROVOLNOVYE METODY ISSLEDOVANIYA PLAZMY. I. DIAGNOSTIKA PLAZMY PO ZATUKHANIYU I OTSECHKE MIKROVOLN. (Microwave Methods of Plasma Study. I. Plasma Diagnostics by Microwave Damping and Cutoff). Dushin, L. A.; Skibenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 36p. (In Russian). Dep. mn.

Methods for the investigation of plasma parameters by microwave damping and cutoff were used in wide application during investigation of various questions of plasma physics. The special characteristics of these methods were deduced. During transverse probing of plasmas, measurement of the amplitude characteristic of signals passed through the plasma made it possible to determine the time and spatial dependence of the density and frequency of compound shocks and, therefore, the temperature of the electrons and processes accompanying the collapse of the plasma (coefficients of diffusion and recombination). Amplitude measurements are greater, the higher the frequency used during plasma probing. (tr-auth)

18638 (FTI-212/R-066) MIKROVOLNOVYE METODY ISSLEDOVANIYA PLAZMY. II. MIKROVOLNOVAYA INTERFEROMETRIYA PLAZMY. (Microwave Methods of Plasma Study. II. Microwave Plasma Interferometry). Dushin, L. A.; Skibenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 39p. (In Russian). Dep. mn.

From the analysis of the methods of plasma study based on the changes of phase passing through the plasma waves, the following conclusions were made. The utilization of the phase measurement at one fixed frequency during transverse probing of the usual field made it possible to follow the changes of the mean density with time from the character of the time dependence; the mechanism of the loss of charged particles could be determined; the coefficients of diffusion and recombination could be found; the temperature could be evaluated; and the size of the plasma parameters and the discharge conditions in the retention process and the character of the density decomposition could be determined. If the spatial distribution does not change with time, then the distribution function was determined from the complete phase displacement during change of the density from critical to zero. The utilization of phase measurements with use of some probing frequencies makes it possible to measure the mean and maximum density and to find the distribution function and its variation with time, the temperature, and the diffusion and recombination coefficients. In investigation of magnetoactive plasmas it is always better to use phase measurements on uncommon waves. The change of these waves makes it possible to study plasmas with densities approaching criticality. The change of uncommon waves makes it possible to find the mean value of the density, the frequencies, and their time dependence. (tr-auth)

18639 (FTI-213/R-067) MIKROVOLNOVYE METODY ISSLEDOVANIYA PLAZMY. III. DIAGNOSTIKA PLAZMY PO REFRAKTSII MIKROVOLN. (Microwave Methods of Plasma Study. III. Plasma Diagnostics by Microwave Refraction). Dushin, L. A.; Skibenko, A. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1966. 35p. (In Russian). Dep. mn.

During oblique probing of heterogeneous plasmas with microwave beams, the distribution functions of the particle densities can be found in strata or the distance from gradients of division of plasma—free space in layers with a given density. The investigation of the spatial distribution can be made by refraction of microwave beams of one of several frequencies in the case of flat or cylindrical plasma configurations. The probing of the plasma cylinder with microwave beams in the horizontal axis makes possible the study of nonhomogeneous plasmas with respect to the gradient and azimuth, in the probing in the plane of the normal axis makes it possible to study nonhomogeneous plasmas with respect to the radius and length of the cylinder axis. The methods for determination of the spatial distribution with utilization of refraction measurements can be used for studies of stationary and pulsed plasmas. (tr-auth)

18640 (IPP-3/42) MESSUNGEN VON ELEKTRISCHER LEITFAEHIGKEIT UND ELEKTRONENTEMPERATUR IN EINEM ARGON-KALIUM-PLASMA BEI VERSCHIEDENEN GASTEMPERATUREN. (Measurement of the Electrical Conductivity and Electron Temperature in an Argon–Potassium Plasma at Various Gas Temperatures). Schwenn, R. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Oct. 1966. 48p. (In German). Dep. mn.

An electric current flowing through a rare-gas alkali plasma causes an increase of the electron temperature, and hence of the electric conductivity. This effect was investigated in a streaming argon–potassium mixture at gas temperatures between 1400 and 2400°K as a function of the electric current density. The conductivity was determined from current–voltage characteristics, while the electron temperature was found by the line-reversal method. For this purpose, the applicability of the line-reversal method for measuring the electron temperature was investigated, with allowance for atom–atom collision excitations. At current densities of 0 to 0.1 A/cm^2 the measured conductivity was much larger than that calculated, especially at low gas temperatures. This excessive conductivity is due to a surplus of electrons carried from the hotter heating system for the gas into the measuring channel. A higher carrier density therefore prevails there than is consistent with the local electron temperature. This phenomenon is caused by relaxation of the recombination. The time dependence of the electron density was calculated in general form. This also showed the conditions under which "preionization" in MHD generators is worthwhile. At current densities above 0.1 A/cm^2, a contraction of the current in the channel was observed at low gas temperatures. Qualitative estimates showed that the resulting increased radiation losses per unit volume of the discharge account for the occurrence of the theoretically unexpected peak in the current–voltage characteristic. At current densities below 1 A/cm^2, the measured conductivity values agree qualitatively with those calculated. (auth)

18641 (NP-16588) MICROWAVE DIAGNOSTIC METHODS APPLIED TO THE JUTPHAAS INJECTION EXPERIMENT. Rijnhuizen Report 66-33. Ornstein, L. Th. M.; Hugenholtz, C. A. J.; van der Laan, H. A.; Huizenga, W.; Strijland, W. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Aug. 1966. 13p. Dep. mn.

Two microwave diagnostic methods have been applied to the Jutphaas Cusp Injection Experiment. The plasma is created by injecting an ion beam into a large vacuum vessel. The plasma causes small phase shifts in an 8-mm interferometer. The minimum phase shift that can be measured is 3×10^{-4} radians, corresponding to a density of about 1.3×10^8 electrons/cm^3. The high sensitivity is obtained by introducing a calibrated phase shifter; furthermore, sensitive detection is made possible by good mechanical and electrical stabilization of the circuitry. The presence of the plasma in the vessel is also indicated by the shift of the frequency of the fundamental electromagnetic resonance of the vessel itself (TM_{010} mode at 419 Mc). The shift can be observed with a certain time resolution. The two methods are applied simultaneously; the results can be correlated. (auth)

18642 (NP-16631) PERCENTAGE IONIZATION IN CROSSED FIELD LABORATORY PLASMA SOURCES. Brown, I. G.; Cross, R. C.; James, B. W.; Watson-Munro, C. N. (Sydney Univ. (Australia). School of Physics). Nov. 1966. 11p. (ER-23). Dep. mn.

The results are presented of an experiment to measure the density of neutral particles in a decaying hydrogenous plasma. A large amplitude Alfven wave is propagated through the plasma and since the reionization energy is small compared with the magnetic energy density in the wave the plasma is completely ionized during the passage of the wave. This gives a measure of the total density of the plasma, from which one can subtract the original ion density to obtain the neutral particle density. This technique was used to determine the radial variation of neutrals in various $\underset{\sim}{J} \times \underset{\sim}{B}$ and hybrid plasmas. (auth)

18643 SERIES REPRESENTATION METHOD FOR OBTAINING THE EMISSION COEFFICIENT FROM THE INTEGRATED INTENSITY DISTRIBUTION FOR ASYMMETRIC LIGHT SOURCES. Maldonado, C. D. (Northrop Space Labs., Hawthorne, Calif.). J. Math. Phys. (N. Y.), 8: 230-9(Feb. 1967).

A procedure for inverting the spectroscopic integral equation which relates the emission coefficient to the integrated intensity distribution for an optically thin and asymmetrical light source is presented. In this procedure the emission coefficient is expanded in terms of a complete set of orthogonal polynomials which are "invariant in form" to a rotation of axes and use is made of the spectroscopic integral equation to determine the unknown expansion coefficients in terms of known information for the integrated intensity distribution. In order to check its validity, the resultant series representation was summed exactly for a hypothetical example corresponding to an asymmetrical source whose emission coefficient possesses elliptical symmetry and diminishes with position in a Gaussian manner. Also the same hypothetical example was used to test the accuracy of the numerical procedure which was developed for summing the series representation in practical situations where the known information on the integrated intensity distribution is presented in the form of experimental data. (auth)

18644 TEMPERATURE AND DENSITY MEASUREMENTS IN FREE JETS AND SHOCK WAVES. Marrone, Paul V. (Univ. of Toronto). Phys. Fluids, 10: 521-38(Mar. 1967).

The fluorescence stimulated by a 17.5-kV electron beam probe

was used to obtain measurements of rotational temperature and gas density in supersonic nitrogen jets expanding from room temperature. The parameter P_0d (where P_0 is the stagnation pressure in torr and d is the orifice exit diameter in millimeters) was varied from 15 to 480 torr-mm. Density measurements were made using an interference filter–photomultiplier combination. The experimental density data follow the axial isentropic density distribution in regions of rotational nonequilibrium. Rotational temperature measurements were obtained from rotational spectra of the 0–0 band of the N_2^+ first negative system. The experimentally determined rotational temperatures, which initially follow the axial isentropic temperature distribution in a free jet, depart from the isentropic curve at low temperatures and freeze at a constant value, indicating a substantial degree of nonequilibrium in the expansion. A shock holder was inserted in the jet and a number of shock waves in the range M = 4 to M = 15 were investigated. Rotational spectra indicate a large departure from a Boltzmann distribution in the rotational levels in the center of a shock front. An apparent non-Boltzmann rotational distribution in the jet expansion was also observed. (auth)

18645 DETERMINATION OF RADIAL VARIATION OF PLASMA ELECTRON DENSITY BY PLASMA RESONATOR. Akao, Yasuo; Ida, Yoshio (Univ. of Nagoya, Japan). Jap. J. Appl. Phys., 6: 525-9(Apr. 1967).

A method was earlier proposed for determining the plasma density utilizing the resonances of surface waves. A recognizable discrepancy between the densities determined from the symmetric mode resonances and those from the dipolar was pointed out. The effect of the radial profile of plasma density, as one of the possible reasons for this discrepancy, is examined and is found to be the most important. The effect, in turn, seems to offer a useful method to estimate experimentally the radial distribution of plasma density. (auth)

18646 DETERMINATION OF LOW PLASMA TEMPERATURES FROM RELATIVE INTENSITIES OF SPECTRAL LINES. Bardocz, A.; Voeroes, T. (Univ. for Technical Sciences, Budapest). J. Quant. Spectros. Radiative Transfer, 7: 331-7(Mar.-Apr. 1967).

The temperatures in a cylindrically symmetrical transparent plasma in local thermodynamic equilibrium were determined at low temperatures for low degrees of ionization by using calculated and measured relative intensities of a spectral line. An analytical method is given for the relative intensities of a spectral line as a function of the discharge-channel axis temperature. The relative intensities of a spectral line as a function of time in a transient spark discharge were determined experimentally by using time-resolving spectroscopic techniques. The two sets of intensity data were normalized to unity and the axis temperature was then determined as a function of the discharge time. In the calculations an experimentally established radial temperature distribution function was used. (auth)

18647 ELECTRON CONCENTRATION AND ENERGY IN A SUPERHIGH FREQUENCY HELIUM DISCHARGE. Maksimov, A. I. (Inst. of Chemical Physics, Moscow). Zh. Tekh. Fiz., 36: 1768-74(Oct. 1966). (In Russian).

Discharges excited by 3KMHz microwave power from a magnetron in spectroscopically pure helium at pressures from 2.5 to 16 mm Hg were investigated in an 11 mm diameter discharge tube. The rf power dissipated in the plasma, the d-c conductivity of the plasma, and the probe characteristics of 0.08 mm diameter tungsten probes were recorded. From the recorded data there were calculated the electron concentration n, the electron temperature T, and the effective electric field E that would give rise to the same power dissipation per electron as was observed in the high frequency discharge. These quantities are presented graphically as functions of the helium pressure p and the discharge power W, and are compared with the analogous quantities for a helium glow discharge. Typical values of n, T, and E/p were 1.5×10^{-11} cm^{-3}, 10 eV, and 8 V/cm mm Hg, respectively. A number of differences between the high frequency discharge and a glow discharge were noted; in particular, T and E/p were higher in the high frequency discharge and remained constant with increasing discharge power under such conditions that the corresponding quantities in the positive column of a glow discharge would decrease with increasing power. It is suggested that these differences between the two types of discharge may be reflected in their optical properties and in the behavior of chemical processes taking place in them. (ATD)

18648 CHARACTERISTICS OF A TOROIDAL DISCHARGE AT LOW PLASMA DENSITY. Babichev, A. P.; Karchevskii, A. I.; Muromkin, Yu. A.; Isakov, I. M. Zh. Tekh. Fiz., 36: 1775-8(Oct. 1966). (In Russian).

Hydrogen plasmas in the aluminum toroidal chamber of the "Beta" installation were investigated. The plasmas were excited in hydrogen at from 0.001- to 0.01-mm Hg by discharge through a pulse transformer of a 0.007 F capacitor bank charged to up to 2 kV and were stabilized with a 0.1- to 1.0-kOe longitudinal magnetic field. The plasma density was measured with a double electric probe and a 2 mm wave length microwave interferometer. When the chamber was well outgassed before the discharge, the plasma density was high (up to 5×10^{13} cm^{-3}) only during the early stage of the discharge and decreased by a factor of from 5 to 20 after 200 or 300 microsec. During the decrease of the plasma density the discharge current decreased in a stepwise manner, and the current breaks were accompanied by simultaneous emission of hard (about 50-keV) x rays from all parts of the chamber. The electric field in the plasma at this stage was approximately equal to the critical value for continuous acceleration of electrons. The experimental data do not permit any definite conclusions to be drawn concerning the mechanism responsible for the observed behavior of the plasmas. (ATD)

18649 STUDY OF SPATIAL DENSITY DISTRIBUTION OF PLASMA BY REFRACTION OF A MICROWAVE RAY WITH SEVERAL FREQUENCY COMPONENTS. Dushin, L. A.; Kononenko, V. I.; Shibenko, A. I. Zh. Tekh. Fiz., 36: 1842-50(Oct. 1966). (In Russian).

Measurement of spatial distribution density of nonuniform plasma by refraction of a microwave ray having several frequency components was studied. Spatial distribution density was measured in a plane normal to and in a plane passing through the axis of a decaying plasma cylinder formed by pulsed induction discharge. Measurements were made by refracting microwave rays in a plane containing the cylinder axis and in a plane perpendicular to the cylinder axis. The equipment used in both cases included a transmitter and a receiver. The transmitter had a high-frequency generator that fed a signal containing 2-, 4-, and 8-mm-wavelength components (providing adequate range for measurement of plasma densities up to 10^{14} particles/cm^2) to the transmitting antenna. The receiver consisted of an antenna, a frequency separator, detectors, preamplifiers, and oscillographs. The latter recorded arrival times of each of the three pulse-component wavelengths at either fixed or varied angular positions of the transmitter–receiver antennas relative to the cylinder axis. Spatial distribution densities calculated from the above data varied between 10^{12} and 10^{14} particles/cm^3. (ATD)

18650 INVESTIGATION OF THE EMISSION OF A DIRECT SELF-CONSTRICTED DISCHARGE (PINCH) IN THE VISIBLE AND ULTRAVIOLET REGIONS. II. FAST DISCHARGE WITH HIGH CURRENT DENSITIES. Likhachev, V. M.; Mikhailov, G. V.; Rabinovich, M. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 107-11(1966). (In Russian).

This is a continuation of a previous investigation, the difference being that it deals with pinch emission in a discharge chamber designed for higher current densities and successively filled with helium, krypton, and hydrogen at pressures of 1 torr. The discharge spectrum of each gas was examined for three different capacitor-battery energies: 135 joules (3 kV), 540 joules (6 kV), and 1200 joules (9 kV). It was found that at 3 kV the observed spectrum consists chiefly of the emission lines of the gas filling the chamber, with the maximum lying in the 4000 Å region. On transition to 6 kV the emission lines of the original gas nearly disappear and a strong line spectrum of impurity, identical for all the gases, is observed; the spectrum shifts toward the uv region (up to 2500 Å). At 9 kV the discharge gives off intense emission in the region of from 6000 to 3500 Å and the spectrum shifts toward the uv region. Comparisons of discharge emission from a xenon lamp of the IFK-2000 type at c = 750 μF, U = 1 and 0.5 kV, point to the possibility of using the pinch as a pulsed source of emission of short duration with a continuous emission spectrum. (JPRS)

18651 INVESTIGATION OF THE EMISSION OF A DIRECT SELF-CONSTRICTED DISCHARGE (PINCH) IN THE VISIBLE AND ULTRAVIOLET REGIONS. I. FAST DISCHARGE WITH LOW CURRENT DENSITIES. Bedilov, M. R.; Likhachev, V. M.; Mikhailov, G. V.; Rabinovich, M. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 97-106(1966). (In Russian).

The optical emission of a direct pinch in the visible and uv region is considered, the principal attention being devoted to the dependence of the emission of the nature of the gas and the initial pressure in the chamber. The pinch was produced with the aid of a cylindrical glass chamber with copper electrodes. Studies of the discharge were carried out with respect to He, Ne, Ar, Kr, Xe, H_2, and air. The discharge was investigated for every gas at pressures of from 10^{-1} to 10 torr. The distribution of glow over the chamber was recorded with a conventional camera. The variation in emission intensity with time was recorded with the aid of a FEU-14B photomultiplier with neutral filters. Spectral emission was analyzed with the aid of an ISP-30 quartz spectrograph.

Results indicated that at high pressures (10 torr and higher) all gases display weak line emission which belongs chiefly in the visible region. As the pressure decreases to 0.1 torr and lower, the emission spectrum shifts toward the uv region. Emission yields are relatively low; e.g., when the energy supplied is 1 kJ, the pinch discharge emits 4 and 2 J in the visible and uv regions respectively: i.e., light yield is ~0.5%. However, emission yields can be augmented by increasing the current density and particle density in the plasma column. (JPRS)

18652 PLASMA SPECTROSCOPY. Cooper, J. (Imperial Coll. of Science and Tech., London). Rep. Progr. Phys., 29: 35-130(1966).

The optical and soft x radiation emitted from an ionized gas is discussed. The details of the emitted radiation (line radiation and line profiles, recombination radiation and bremsstrahlung) and the possible effects of radiative transfer are considered. The theoretical assumptions are examined and stressed, and experiments are discussed only when they have a direct bearing on the theoretical predictions. In particular, a large section is devoted to line-broadening theory. This is because it is in this field, especially through the generalized impact approximation for electrons, that great improvements in theory have been made in recent years. Since it is necessary to know the properties of plasmas, both in fusion research and in experiments to measure atomic parameters of highly excited and highly ionized species, methods for measuring number densities and temperatures are described. In particular, methods are discussed which can be used in high-temperature plasmas which are not in local thermodynamic equilibrium. Radiation losses due to impurities of high electronic charge are shown to be an extremely important energy loss mechanism for the hydrogen (deuterium) plasmas studied in controlled fusion research. Finally, some of the outstanding problems in plasma spectroscopy are mentioned. (M.O.W.)

18653 THEORETICAL ASPECTS OF THE INDUCTION METHOD OF PLASMA PARAMETERS MEASUREMENT. Brunne, M. (Inst. of Fluid-Flow Machines, Danzig). Bull. Acad. Pol. Sci., Ser. Sci. Tech., 14: 1039-46(1966).

The problem of interaction between an induction coil fed with oscillating current and a jet of quasi-neutral plasma was analyzed. A macroscopic description based on the laws of electrodynamics of continuous media was used. A concise representation is given of some of these results. (M.O.W.)

18654 LASER PHASOGRAPHY OF JETS, SHOCKS, AND PLASMAS. Presby, Herman. M. New York, Yeshiva Univ., 1966. 116p.

Thesis.

The phase-contrast microscope of Zernike may be scaled in size and combined with "giant pulse" ruby-laser illumination to make possible the observation of macroscopic moving tenuous objects, such as jets, shock waves, and plasmas. The resulting instrument, referred to as the Laser Phase Macroscope (L.P.M.), has performance similar to that of an optical interferometer operated in the single-fringe mode. The operation of the phase macroscope is treated theoretically, first heuristically and then by diffraction integrals. Conditions for optimum imaging are derived. The "phase plate" of Zernike is modified for use with focused laser illumination, and parameters for optimum imaging are given. Quite different mirrors are required for the full range of interesting plasmas accessible to the L.P.M. The experimental model is described. Phasograms of weak and strong shocks in air and argon down to 0.5 mm Hg pressure are shown. Rayleigh–Taylor instability behind the shock is observed. Gas jets of various refractivities are also used as test objects. Phasograms of vacuum sparks producing jets of ablated electrode material are shown. Many objects studied are invisible to schlieren photography using the same illumination and optics. (TSS)

18655 AFTERGLOW STUDIES IN GASEOUS PLASMAS. Gerber, Robert Arthur. Minneapolis, Univ. of Minnesota, 1966. 118p.

Thesis.

In an attempt to eliminate a few of the earlier discrepancies and uncertainties a diagnostic system was designed which measures simultaneously, during the plasma afterglow period, the time dependence of (a) the intensity of spectral lines and bands, (b) the density of the various ions present in a plasma and (c) the density of metastable excited atoms. This diagnostic system employs a quadrupole mass spectrometer combined with a light spectrometer and/or interference filters. A comparison of the time dependence of each ion species with that of the intensity of spectral lines and bands should result in the determination of the type of electron-ion recombination responsible for the light emission in decaying plasmas. The present studies are primarily concerned with low pressure plasmas produced in helium and neon. Results obtained by simultaneously measuring the time dependence of the various ion densities and the intensity of the atomic light emission are included. The purpose of these studies was twofold; First, to determine if it was feasible to simultaneously apply mass spectrometer and light spectrometer techniques to plasma afterglows and second, to determine if the results obtained could be given a valid interpretation. Helium and neon were chosen for these studies because discrepancies existed about the origin of the atomic light emission during the afterglow period of plasmas produced in these gases. In addition, since the mobility values of helium and neon atomic ions are well known, these gases provided the necessary comparison to determine the reliability of the results obtained from mass spectrometric probing of decaying plasmas. The values obtained for the mobility of He^+ in helium and Ne^+ in neon are in excellent agreement with the values obtained by other measuring techniques. Moreover, this method of studying decaying plasmas has been shown to be superior to the microwave cavity method, since it permits the study of larger number density ranges and also gives information about the properties of minority ions. The study of the relation between the time dependence of the number density of atomic and molecular ions and that of the intensity of spectral lines has led to the following two main conclusions about the origin of the light emitted during the afterglow period: (a) In helium the emission of spectral lines in the range of 3000 to 7000 Å is a consequence of the collisional-radiative recombination process, $He^+ + 2e \rightarrow He^* + e$. (b) In neon the time dependence of the light intensity indicates that more than one recombination process is responsible for the light emitted. It is believed that the emission of spectral lines originating from the 4d energy levels is mainly caused by a recombination process involving Ne^+, while the emission of lines originating from the 2p and 3p levels is mainly a consequence of the dissociative recombination process, $Ne_2^+ + e \rightarrow Ne^* + Ne$. (Dissertation Abstr.)

18656 EFFECTS OF GAS HEATING AND VOLUME RECOMBINATION ON ELECTRON DENSITY PROFILES IN THE POSITIVE COLUMN. Lynch, Robert Hugh. Norman, Okla., Univ. of Oklahoma, 1966. 80p.

Thesis.

The principles of kinetic theory are applied to the derivation of three simultaneous equations for gas temperature, electron temperature, and electron density as functions of radial distance from the axis of a discharge in a cylindrical tube. Values of the coefficients in the equations were chosen so that the results obtained would apply approximately to a discharge in helium. The solution of these equations by a computer gives more or less constricted radial profiles of electron density. The degree of constriction is found to increase with the two parameters (tube radius times pressure) and (current times pressure). It is also found that the parameter (electric field strength/pressure) decreases as the parameter (current times pressure) is increased. The results obtained for helium in this work are expected to be qualitatively similar to those for the heavier inert gases. Since, however, the coefficient of dissociative recombination is much higher for the heavier gases than it is for helium, the constriction is expected to set in at much smaller values of the parameter (radius times pressure) in the former. (TSS)

Kinetics of Plasma

Refer also to abstracts 17942, 18376, 18439, 18493, 18508, and 18630.

18657 (AD-637229) EXPERIMENTS ON ION-ACOUSTIC WAVES. Scientific Report No. 6, June 1, 1965–May 1, 1966. Nilsson, P. O. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Contract AF 61(052)-895. 61p. (RADC-66-499). CFSTI $3.00 cy, $0.65 mn.

Propagation of ion–acoustic waves has been studied experimentally in a low-pressure mercury discharge. Both self-excited and externally excited waves were observed in the frequency range 40 to 130 kHz. No static magnetic field was applied. The influence of the neutral gas pressure, electron density, discharge current, and tube diameter on the properties of the ion waves was examined. Different types of exciters were used. An experimental dispersion curve is compared with theoretical results. It is shown that at some values of the steady state parameters the ion waves propagate completely undamped along the whole plasma column. Finally a comparison is made between the noise frequency spectrum and the frequency dependence of the ion waves. (auth)

18658 (AD-640372) GENERATION AND AMPLIFICATION OF MICROWAVES BY INTERACTION OF ELECTRON BEAMS AND PLASMA. Annual Summary Report No. 1, June 1, 1965–May 31, 1966. Agdur, Bertil (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). June 30, 1966. Contract AF 61(052)-895. 12p. (RADC-TR-66-589). CFSTI $3.00 cy, $0.65 mn.

Among the problems treated are mode coupling in inhomoge-

neous plasmas, coupling of waves through plasma structures, nonlinear wave interaction in plasmas, variation of electron density, and neutral gas density along a low-pressure mercury vapor discharge, microwave emission from InSb and laser diagnostics of solid-state plasmas. (auth)

18659 (AD-641360) REMOVAL OF HYDROGEN IMPURITIES IN CLOSED NOBLE GAS DISCHARGE SYSTEMS. Buser, Rudolf G.; Sullivan, John J. (Army Electronics Command, Fort Monmouth, N. J.). Aug. 1966. 32p. CFSTI $3.00 cy, $0.65 mn.

The removal of hydrogen, considered as an impurity gas, from a closed noble gas (helium) discharge system is studied using the techniques of (1) hydrogen pumping through a heated palladium membrane and (2) hydrogen gettering by a titanium film deposited on a water-cooled stainless-steel surface. Mass spectrometric and optical measurements are presented which show the effect of helium background on hydrogen removal rate. Experimental results of hydrogen gettering on titanium agree with theoretical calculations based on kinetic theory, and not only support, but extend earlier work of other investigators. Removal of hydrogen by the palladium membrane is about equally effective for the geometry employed. In addition, laser transmission measurements of deposition of titanium films on a glass surface are studied. Dependence of deposition rate and film thickness on helium background pressure and source temperature is shown. (auth)

18660 (AD-642242) VARIATIONAL METHOD FOR UNSTEADY ONE-DIMENSIONAL PLASMA FLOW OF THE TYPE V PERPENDICULAR TO B. Herrnegger, Franz (Innsbruck Univ. (Austria). Institut fuer Theoretische Physik). Sept. 30, 1966. Contract AT 61(052)-675. 21p. (AFOSR-66-2454). CFSTI $3.00 cy, $0.65 mn.

The well-known variational principle of the plane steady gasdynamical potential flow is generalized to unsteady plane MGD potential flow of the type v perpendicular to B. It is shown that the formulation of the variational principle in the independent variable p (pressure) is possible for arbitrary adiabatic exponent, but the formulation in the velocity potential is possible only for special values of the adiabatic exponent. (auth)

18661 (AFCRL-66-826) EXPERIMENTAL OBSERVATIONS OF THE STRUCTURE OF SHOCK WAVES IN A COLLISION-FREE PLASMA. Final Report, November 1, 1961–October 31, 1966. Griem, H. R.; Goldenbaum, George C. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Nov. 1966. Contract AF 19(628)-269. 91p.

The contract provides partial support for the following: (1) laboratory and theoretical investigations of shock propagation in a rarefied plasma; (2) laboratory and theoretical investigations of interaction of shock waves and turbulence with magnetic fields; (3) laboratory simulation and accompanying theoretical study of the properties of interstellar material; (4) laboratory studies with supporting theoretical investigations leading to an understanding of the basic laws of magnetogasdynamics; and (5) experimental support of theoretical in-house investigations of magnetic shock waves and related problems in plasma physics, particularly, observational verification of the structure of magnetic shock waves in a plasma as predicted by current theoretical in-house investigations. With the exception of Item 3, work in all desired categories centered around a collision-free shock wave experiment utilizing a fast theta pinch apparatus. Results obtained with this apparatus are reported. They bear on Item 1 through the successful laboratory production and theoretical discussion of shock waves in a nearly collisionless plasma, on Item 2 through the possible interpretation of the shock thickness through a turbulent structure, on Item 4 through the generation and interpretation of large-amplitude compressional plasma waves in general, and finally on Item 5, again through the experimental demonstration of the existence of collisionless shock waves in magnetoplasmas as predicted theoretically. (M.O.W.)

18662 (AFCRL-66-827) ANALYSIS OF ELECTROMAGNETIC RADIATION IN THE PRESENCE OF UNIFORMLY MOVING GENERALIZED MEDIA. Scientific Report No. 15. Besieris, Ioannis M. (Case Inst. of Tech., Cleveland, Ohio). Nov. 1966. Contract AF19(628)-1699. 157p.

Thesis.

The electromagnetic field intensities associated with an isotopic, conducting, moving medium are expressible in terms of a pair of scalar and vector potential functions by invoking a generalized Helmholtz theorem and a modified Lorentz condition. The time-dependent scalar Green's function defined in connection with the partial differential equations satisfied by these potential functions is determined explicitly by resorting to an expansion of a function of a diagonalizable matrix. The radiation due to a magnetic dipole oriented along the distinguished axis of a stationary, conducting, uniaxially-anisotropic medium is found by writing separate equations for the electromagnetic field intensities, and utilizing a spectral representation in the space–time Fourier domain. The electric conductivity and permittivity tensors are assumed to be proportional to each other. The change in the character of radiation in the presence of a uniaxially anisotropic medium uniformly in the direction of its axis of symmetry is investigated next. Because of the existing symmetry, it is possible to obtain explicit analytic solutions for a longitudinally and a transversely oriented unit magnetic current distribution density. Finally, the exact radiation field in a general anisotropic, conducting, moving medium is presented formally as an integral representation in terms of the generalized spectrum of a nonsemisimple matrix. (auth)

18663 (ARL-66-0239) FREE-FREE RADIATION AT VERY HIGH DENSITY. Chakraborty, B. B.; Oster, L. (Yale Univ., New Haven, Conn. Observatory). Nov. 1966. Contract AF33-(615)-2360. 27p. CFSTI $3.00 cy, $0.65 mn.

A semi-classical treatment of free–free radiation (bremsstrahlung) at very high densities is presented, concentrating on the collective behavior of the plasma. General formulas useful for numerical calculations, as well as expansions in terms of Bessel functions, are given. Quantum effects and the limitation to nonrelativistic, nondegenerate plasmas are discussed. Numerical results are then presented for the temperature range 10^4 to 10^{7}°K, and for electron densities of 10^{20} to 10^{24} per cm^3. It is shown that there exists a very limited frequency variation over the above range of temperatures and densities. (auth)

18664 (IPP-3/48) UNTERSUCHUNG DES DRUCKAUFBAUS EINER STATIONAEREN, MAGNETFELDSTABILISIERTEN HELIUM-ENTLADUNG MIT HILFE MAGNETISCHER MESSUNGEN. (Investigation of the Pressure Build-Up of a Stationary, Magnetically Stabilized Helium Discharge by Magnetic Measurements). Klueber, O. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Dec. 1966. 135p. (In German). Dep. mn.

Thesis.

The pressure buildup of a stationary, linear discharge in the field of a cylindrical coil is investigated experimentally. The difference between the pressure of the plasma near the axis and that in the neutral gas surrounding the plasma is about 1 atmosphere inside the field coil. This difference is due to ring currents in the plasma, which together with the meridional field cause a radial pressure rise, and to the compression of the plasma by the field of the discharge current (pinch effect). This azimuthal field is small in magnitude compared with the meridional magnetic field, which is composed of the external field produced by the coil and the meridional component of the internal field that is due to the ring currents in the plasma. The flux $\phi^{(i)}$ of this internal field through induction coils surrounding the discharge tube can be separated by a compensation method from the flux $\phi^{(a)}$ of the coil field, which is 10^3 times greater. Apart from a geometry factor, $\phi^{(i)}$ is given by $\int j\rho(r,z)r^2dr$. From this quantity it is possible to determine the contribution of the ring currents to the pressure buildup. Inside the coil this contribution greatly exceeds that of the pinch effect. It is shown that the pressure rise in the transition region between the neutral gas envelope and the completely doubly ionized core of the plasma is mainly caused by the already investigated influence of the ambipolar diffusion, and also that the pressure continues to rise in the core of the plasma. This is due to a thermomagnetic effect, the Nernst effect, whose influence on the pressure buildup of a plasma has not been investigated hitherto. (auth)

18665 (LA-DC-8213) THEORY OF VELOCITY DISTRIBUTIONS ASSOCIATED WITH BOUNDED QUIESCENT PLASMAS. Dreicer, H.; Riesenfeld, W. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 5p. (CONF-670104-5). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

An investigation is under way, utilizing the Fokker–Planck equation for inverse square forces, which seeks to determine the nature of the electron velocity distribution function in a bounded quiescent plasma. (auth)

18666 (MPI-PAE-PL-2/67) DERIVATION OF THE QUANTUM VLASOV EQUATION AND DISPERSION RELATION OF A RELATIVISTIC ELECTRON GAS. Biskamp, D. (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Feb. 1967. 10p. Dep. mn.

The self consistent field equation (Vlasov equation) is derived for the one-particle Wigner function of a relativistic electron–positron gas. From the linearized form one obtains the dispersion relation for any quasi equilibrium, which has already been derived for the special case of thermal equilibrium by Tsytovich. (auth)

18667 (N-66-24978) VLASOV EQUATIONS. Chou, Chih Kang (Northrop Space Labs., Huntsville, Ala.). Nov. 1965.

Contract NAS8-11440. 89p. (NASA-CR-74673; E-20-151). CFSTI $3.00 cy, $0.65 mn.

As a preliminary step in investigating the dynamics of a collisionless plasma, a comprehensive literature survey is conducted. Emphasis is placed on those aspects of the recent theoretical development which may shed light on a better approximation for the solution of the Vlasov equations. All relevant equations of classical mechanics, classical electrodynamics, and hydrodynamics are either displayed in a suggestive manner or derived from fundamental principles and incorporated in the text of this report. A brief but self-contained review of kinetic theory is given, and the microscopic hydrodynamical equations are derived on the basis of the Boltzmann equation for a dilute neutral gas based on a hard sphere model. Classical statistical mechanics is cast in a form which is particularly suited for its application to plasma dynamics. Liouville's theorem is applied to a relativistic electron gas with a positive ion background. The Vlasov–Boltzmann equation is obtained from Liouville's theorem on the basis of the self-consistent field formalism of Rostoker and Rosenbluth. The Born–Bogolyubov–Green–Kirkwood–Yvon hierarchy is derived from the relativistic Liouville equation. Corrections to the Vlasov–Boltzmann equation in terms of the multiparticle correlation function technique are also discussed. (auth)

18668 (N-67-13101) PHYSICAL PROCESSES IN AN MPD ARC. First Semiannual Report. Lovberg, R. H. (California Univ., La Jolla, San Diego). Nov. 29, 1966. 17p. (NASA-CR-80452). CFSTI $3.00 cy, $0.65 mn.

An accelerator and its associated vacuum facility was constructed. The accelerator was operated with argon propellant, and an initial survey of its impedance characteristics was made. Results of these tests are summarized. The general engineering features of the device itself, in terms of problems arising from project criteria and the solutions to them, are outlined. Probes were used as the main diagnostic tool to determine, as far as possible, the interior physical characteristics of a maximum permissible dosage arc. The current flow was held to short pulses. The various components of the systems, which are described in some detail, are accompanied by photographs. (STAR)

18669 (NP-16637) WILLS PLASMA PHYSICS DEPARTMENT TWELFTH SIX-MONTHLY PROGRESS REPORT, JULY 1–DECEMBER 31, 1966. (Sydney Univ. (Australia). School of Physics). 10p. (PR-12). Dep. mn.

Brief summaries of continuing research at the Sydney University School of Physics are presented. The areas mentioned are: plasma sources, plasma preparation, compressional wave studies, large amplitude Alfven waves, microwave reflection studies, and longitudinal microwave propagation. (M.O.W.)

18670 (NP-16641) THE EFFECTS OF A DENSITY GRADIENT ON THE MAGNETO-KERR EFFECT AT THE BOUNDARY OF A COLLISIONAL PLASMA. Heckenberg, N. R.; Robinson, L. C.; Rothman, G. P. (Sydney Univ. (Australia). School of Physics). Oct. 1966. 11p. (ER-22). Dep. mn.

Results are presented of calculations showing the effects of collision frequency and surface-density gradient on the polarization of microwaves reflected from a plasma surface. Experimental observations are compared with these results and estimates are made of the collision frequency and density gradient. (auth)

18671 (NP-16661) NONLINEAR MECHANICS OF UNSTABLE PLASMAS. Quarterly Progress Report, October 1–December 31, 1966. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jan. 20, 1967. 9p.

A brief discussion of construction progress on the thermal plasma device (Q machine) is presented. In particular, the vacuum chamber, experimental platform, and magnet system are briefly described. (M.O.W.)

18672 (ORO-3405-14) MATHEMATICAL MODELS FOR NONLINEAR MODE INTERACTIONS IN BOUNDED PLASMAS. Lashinsky, Herbert (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Oct. 1966. Contract AT(40-1)-3405. 39p. (BN-473). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Mathematical models are devised that will reproduce a number of physical phenomena that have been observed in experiments on instabilities in continuous operating plasma devices. In particular, the description of self-excited, steady-state oscillation in systems that can oscillate in more than one mode simultaneously is discussed. The approach used here is essentially an extension, to disturbed systems, of techniques used in the nonlinear mechanics of lumped-parameter systems. The analysis is limited to spatially bounded systems and the mathematical approach is based on two concepts: (1) asymptotic expansion with respect to a suitably defined small parameter, which will define the magnitude of the nonlinearities that are involved, and (2) expansion in terms of eigenfunctions of linear operators. (M.O.W.)

18673 CLASSICAL STATISTICAL THEORY OF EQUILIBRIUM SYSTEMS OF CHARGED PARTICLES. Yukhnovskii, I. R.; Nekrot, A. A. Ukr. Fiz. Zh., 12: 177-85(1967). (In Russian).

The parameters of equilibrium plasma and the contribution to free energy from the domains corresponding to these parameters are determined. The results are compared for the binary distribution function obtained with the help of the group integral method and collective variables and Bogolyubov's method of plasma parameter expansion. (auth)

18674 EXCITATION OF ELECTRON-PLASMA WAVES BY THE INTERACTION OF AN ION BEAM WITH A PLASMA. Herrmann, W.; Fessenden, Th. J. (Institut fuer Plasmaphysik, Garching, Ger.). Phys. Rev. Lett., 18: 535-7(Apr. 3, 1967).

The interaction of an energetic beam of ions with a plasma that is produced by the ion beam is discussed. The experimental arrangement using hydrogen ions and hydrogen gas is described. (M.O.W.)

18675 WAVE TRANSFORMATION IN A WEAKLY INHOMOGENEOUS PLASMA. Piliya, A. D. (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekh. Fiz., 36: 2103-6(Nov. 1966). (In Russian).

The problem of wave transformations can be reduced to the differential equation of the 4th order. The simplest expression of this type equation, $f^{IV} + \lambda^2(\gamma f'' + u_0 f) = 0$ was formerly analyzed by the Laplace method, and (with $\lambda^2 \gg 1$) by the method of phase integration. However, in some problems, the equation is more complex, e.g., the transformation in a heterogeneous isotropic plasma, or the transformation of wave propagation perpendicular to a magnetic field at a point of hybrid resonances in which the oscillations are described by $Df = \gamma g(\rho)\varphi''$, $\gamma\varphi'' - (a\gamma + \rho)\varphi = f$ (where $Df \equiv f'' - p(\rho)f' - q(\rho)f$,g and at least one of the functions p or q have in the point $\rho = 0$ the first-order pole, with the residue equal to the positive number or zero); γ is the small parameter $\gamma \ll 1$ and a is the constant of the order of a unit. The first equation is constructed on the basis of the second and third equations, with $a = p = 0$, $-g = q = (1/\rho)$, $\gamma = (u_0^2/\lambda_2)$, $\rho = -u_0\gamma$. Arguments are presented to show that the system describes all cases in which the coefficient of transformation is of the order of a unit (in relation to γ). (R.V.J.)

18676 ENERGY SPECTRA OF IONS IN ACCELERATED PLASMA. Voitsenya, V. S. Zh. Tekh. Fiz., 36: 2098-2100 (Nov. 1966). (In Russian).

Energy distribution of ions in a fast plasma cluster ejected from a coaxial source was studied using Thompson mass spectrometers. It was revealed that the most probable energy value per charge is identical for all fast ions. (R.V.J.)

18677 CHARGE RECOMBINATION AT PLASMA DECAY IN HELIUM AT HIGH PRESSURE WITH POTASSIUM VAPOR ADMIXTURE. Polushkin, I. N. (Kiev State Univ.). Zh. Tekh. Fiz., 36: 2093-4(Nov. 1966). (In Russian).

Charge recombination in plasma decay in helium and in argon at constant pressure of 100- to 150-mm Hg and with cesium vapor admixture at a pressure of 10^{-6}- to 0.1-mm Hg was studied previously by Morgulis et al. (Zh. Tekh. Fiz. XXXVI, No. 3, 1966). The published data and method are expanded for the case of potassium vapor at a pressure of 10^{-6}- to 0.1-mm Hg and constant helium pressure of 60-mm Hg with the charged particle concentration and electron temperature identical to the previous work. Results of the measurements are given in graphical form. The recombination coefficient α as a function of the potassium vapor pressure in the He–K plasma is identical to that obtained for cesium in the He–Cs and Ar–Cs plasmas. (R.V.J.)

18678 KINETIC THEORY OF ELECTROMAGNETIC WAVES IN A LIMITED MAGNETOACTIVE PLASMA, II. Kondratenko, A. N. Zh. Tekh. Fiz., 36: 1943-54(Nov. 1966). (In Russian).

Dispersion equations previously obtained for electromagnetic waves propagating in an infinite homogeneous plasma layer along the external magnetic field distributed parallel to the plasma boundary were examined. High-frequency oscillations, low-frequency waves in a low-pressure plasma, and low-frequency oscillations of nonisothermal plasma in a magnetic field were analyzed. (R.V.J.)

18679 MAGNETIC MEASUREMENTS IN A COAXIAL SOURCE. Belikov, A. G.; Goncharenko, V. P.; Mishchenko, V. M. Zh. Tekh. Fiz., 36: 1984-9(Nov. 1966). (In Russian).

Performances of the coaxial source were compared during high-energy particle generation and during slow cluster production. The current characteristics, voltage, and magnetic field distribution along the electrode length were measured for the two operations. The presence of a secondary breakdown was found. An increased first half period in the fast particle regime was observed. The possible influence of the secondary breakdown momentum on the duration of the first half period of the battery discharge was examined. (tr-auth)

18680 NONEQUILIBRIUM EXCITATION OF NEUTRAL HELIUM IN PLASMAS OF MODERATE DENSITY. Johnson, L. C. (Princeton Univ., N. J.). Phys. Rev., 155: 64-8(Mar. 5, 1967).

Detailed rate equations for the excitation of neutral helium are solved, using a variety of assumed cross sections, and the resulting population densities are compared with measurements on stellarator ohmic heating discharges and afterglows. It is shown that the experimental results can be satisfactorily reproduced by using for electron impact excitation cross sections for all optically allowed transitions a function $(\ln U)/U$ scaled according to the Bethe approximation, where U is the ratio of incident electron energy to the excitation energy. If the assumed cross sections differ from this near the threshold by more than a factor of $\frac{1}{3}$, satisfactory agreement with measurements is not obtained. Other items of interest in the analysis of laboratory and astronomical plasmas are also discussed. (auth)

18681 CONVERGENT KINETIC EQUATION FOR A CLASSICAL PLASMA. Gould, Harvey A. (Univ. of California, Berkeley); DeWitt, Hugh E. Contract W-7405-eng-48. Phys. Rev., 155: 68-74(Mar. 5, 1967). (UCRL-70095).

A general quantum-mechanical transport equation is used to derive a kinetic equation for an electron gas, which in the classical limit is not subject to the usual short-range divergence and is exact to first order in the plasma parameter. The method is based on a direct analogy with the well-known equilibrium theory of the electron gas. No arbitrary separations or cutoffs are necessary. The resulting collision integral is similar to that of Weinstock and of Frieman and Book, but the Boltzmann and Fokker–Planck terms are evaluated for the static screened Coulomb potential instead of the bare Coulomb potential. It is shown that the equation of Guernsey, although convergent, does not contain all first-order contributions in the plasma parameter, and that the equations of Weinstock and of Frieman and Book must be carefully interpreted to achieve correct results. Numerical results, given in the classical limit for the dc electrical conductivity, explicitly exhibit the dominant and nondominant terms. (auth)

18682 MICROSCOPIC APPROACH TO KINETIC THEORY. Chappell, Willard R. (Smithsonian Astrophysical Observatory, Cambridge, Mass. Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 8: 298-305(Feb. 1967).

A microscopic kinetic theory is developed for a plasma by the use of approximate equations of motion for the microscopic "exact" distribution function $\hat{f}(\mathbf{r}, \mathbf{v}, t) = \Sigma_{i=1}^{N} \delta(\mathbf{r} - \mathbf{r}_i(t))\delta(\mathbf{v} - \mathbf{v}_i(t))$. These equations can be solved to obtain asymptotic expressions for $\hat{f}(\mathbf{r}, \mathbf{v}, t)$ that are then used to calculate correlation functions. These approximate equations are also used to obtain the approximate equations for the correlation functions and the principal results of the test-particle approach. In particular, two sets of equations are constructed. One set describes a homogeneous, slowly varying system and yields the Balescu–Lenard equation. The other set describes a homogeneous, slowly varying system that contains small, inhomogeneous and quickly varying perturbations. (auth)

18683 RELAXATION TO EQUILIBRIUM OF A DILUTE ELECTRON PLASMA. McLeod, J. B. (Oxford Univ.); Ong, R. S. B. J. Math. Phys. (N. Y.), 8: 240-7(Feb. 1967).

The relaxation of the velocity distribution to equilibrium in an electron plasma in which the dominant collisions are described by the Fokker–Planck operator is studied. It is shown mathematically that the linearized collision operator possesses a continuous spectrum of eigenvalues which extends over the entire real interval from zero to infinity. Consequently the decay to equilibrium is not uniformly exponential. For large values of the time the decay to Maxwellian is shown to be of the order of the inverse power of the time variable. Moreover the rate of decay depends also on the initial perturbation. (auth)

18684 OSCILLATIONS OF A MAGNETIZED PLASMA WITH ANISOTROPIC INITIAL DISTRIBUTION. Anderson, J. T. (Cambridge Univ., Eng.). Proc. Phys. Soc. (London), 90: 715-28(Mar. 1967).

The oscillations of a magnetized plasma are studied for arbitrary initial distributions of the electrons and ions. A dispersion equation is derived and it is found that the effect of an anisotropy is to add first-, third- and fifth-order terms to the usual fourth-order equation for an isotropic distribution. The dispersion equation for longitudinal oscillations is found to have the same form for all distributions, but the equation for transverse oscillations contains an additional term due to the anisotropic part. Longitudinal electron oscillations are studied for an arbitrary distribution along the magnetic field and a Maxwellian distribution in the transverse plane. Complex frequencies are found in the long- and short-wavelength regions. To first order the real part of the frequency γ for long wavelengths is independent of the magnetic field but is a functional of the distribution function. For short wavelengths γ is independent of the distribution but exhibits logarithmic oscillations characteristic of the field. (auth)

18685 STUDIES OF A COAXIAL E × B PLASMA GUN. Steinhaus, James F.; Barr, William L.; Oleson, Norman L. (Univ. of California, Livermore). Phys. Fluids, 10: 641-7(Mar. 1967). (UCRL-12078).

The hydrogen plasma produced by a coaxial E × B gun located in a magnetic mirror system was extensively studied. When the gun was externally shorted (crowbarred) at peak avalanche current, the magnitude of the reverse current due to the angular momentum of the rotating plasma was found to depend on the axial position of the gun with respect to the upstream magnetic mirror. Microwave measurements gave a maximum electron density of 1.7×10^{13} cm^{-3} in the presence of neutrals of 10^{14} cm^{-3} with electron decay times of 300 to 400 μsec in the 10^{11} to 10^{12} per cm^3 range. Analysis of the optical spectra showed the presence of H, H_2, Fe, Fe^+, Cr, Cr^+, Mn, Mn^+, and Mo, and indicated that the electron temperature was approximately 5 eV. Evidence is presented which indicates that internal shorting of the discharge is the result of a low-resistance path developing along the axial magnetic field lines to the downstream chamber walls. Floating probe measurements revealed that the electric field depended both on current and radial position, and showed little evidence of an anode sheath. Some measurements were also taken with helium and nitrogen as working gases. (auth)

18686 RESONANT OSCILLATION IN A PIG DISCHARGE. Tanaka, Yuji; Yamamoto, Kenzo (Univ. of Nagoya, Japan). Jap. J. Appl. Phys., 6: 520-4(Apr. 1967).

Several types of coherent oscillations at frequencies between 10 and 100 kHz are observed in a PIG discharge under a restricted condition when the magnetron motion of electrons around the plasma column perturbs the plasma. This perturbation propagates in the plasma column as a wave. The wave is resonant with the bounded plasma column, and consequently the low-frequency oscillation is observed in the discharge. Three different waves, i.e., the ion-acoustic wave, the slow hydromagnetic compression wave, and the hydromagnetic shear wave are identified. (auth)

18687 TURBULENT SHOCK WAVES IN PLASMAS. Tidman, D. A. (Univ. of Maryland, College Park). Phys. Fluids, 10: 547-64(Mar. 1967).

A model for a turbulent shock wave with a structure determined by ion wave instabilities is discussed. Quasi-linear theory for spatially growing waves is used to examine the spatial buildup of the turbulent spectrum in the leading edge of the shock transition. Although the principal calculations are made for an electrostatic shock, the response of a weak magnetic field in the plasma to such a thin ion-wave shock is also discussed. It is suggested that the earth's bow shock in the supersonic solar wind may sometimes have a structure of the type described here and a comparison with satellite data for this shock wave is made. (auth)

18688 OBLIQUE INCIDENCE OF AN ELECTROMAGNETIC WAVE ON PLASMA HALF-SPACE. Weston, Vaughan H. (Univ. of Michigan, Ann Arbor). Phys. Fluids, 10: 632-40(Mar. 1967).

A radio frequency electromagnetic wave, polarized in the plane of incidence is incident obliquely upon a plasma half-space, where the equilibrium plasma is taken to be homogeneous and isotropic. Employing the specular boundary condition, an exact solution of the coupled Maxwell–Vlasov equations is derived, yielding both transverse and longitudinal waves in the plasma region. The reflection coefficient is derived, and approximately evaluated. (auth)

18689 SOLUTION OF THE BORN-GREEN-YVON EQUATION FOR A HIGH DENSITY ONE-COMPONENT PLASMA. Hirt, C. W. (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 10: 565-70(Mar. 1967). (LA-DC-8219).

Recent Monte Carlo calculations of the radial distribution function of a one-component, classical, plasma are shown to be well approximated by solutions of the Born–Green–Yvon integral equation, almost up to densities where there is definite short range order. The Born–Green–Yvon solutions appear to be somewhat better than the corresponding solutions of the Percus–Yevick and convolution-hypernetted-chain equations. The Born–Green–Yvon equation is further shown to be related to the original Debye–Hückel equation for an ionic solution. It differs from the latter equation by accounting for more short range correlations, a feature that makes it more accurate at higher densities. The special methods used to obtain numerical solutions of the Born–Green–Yvon equation at high density are briefly discussed. (auth)

18690 THIRD-ORDER OSCILLATIONS IN A MAXWELLIAN PLASMA. Gary, S. Peter (Washington Univ., St. Louis). Phys. Fluids, 10: 570-81(Mar. 1967).

Nonlinear plasma oscillations in a classical, nonrelativistic,

collisionless, Maxwellian electron gas are considered. There is assumed a small, sinusoidal variation in the spatial part of the initial distribution function, corresponding to excitation of wave-number modes $\pm k_0$. The nonlinear Vlasov equation is solved to third order in the long time limit via the Montgomery–Gorman perturbation expansion, where the expansion parameter is ϵ, the amplitude of the initial perturbation. The linear, first-order k_0 mode of the electric field is dominated by the Landau solution with (negative) damping decrement γ_L. The third-order k_0 mode is modified, however, by singling out the spatially uniform part of the distribution function for special treatment, much in the manner of the quasi-linear theory. A nonlinear damping decrement results such that, for many values of k_0 and ϵ, $\gamma_L < \gamma_N$. Thus at sufficiently long times, the modified third-order mode dominates the solution. For certain ϵ and k_0 this behavior resembles the results of Knorr and Armstrong, obtained by numerical integration of the nonlinear Vlasov equation. (auth)

18691 EXPERIMENTAL INVESTIGATION OF HARMONIC ION CYCLOTRON WAVE PROPAGATION AND ATTENUATION. Kristiansen, Magne; Dougal, Arwin A. (Univ. of Texas, Austin). Phys. Fluids, 10: 596-604(Mar. 1967).

A new wave phenomenon was observed in the course of an experimental investigation of ion-cyclotron resonance heating of hydrogen and deuterium plasmas in strong magnetic fields. It was found that the waves can propagate for frequencies larger than the ion cyclotron frequency f_c, and attenuate at harmonics of f_c with resulting increase in the transverse temperature–density product $n\beta T_\perp$. The harmonic number at which the waves attenuate increases with increasing gas pressure. Attenuation at harmonics up to the 8th was observed. The plasma density is typically 6×10^{17} m^{-3}, the transverse plasma temperature ($T_{e\perp} + T_{i\perp}$) $\gtrsim$ 50-eV equivalent, and the magnetic field 1 to 9 kG. A magnetic beach geometry is employed and the waves are excited by a Faraday-shielded Stix coil from a 30-kW, 5.8-MHz driver. Harmonic cyclotron heating is related to large transverse wave numbers which are shown to exist in the experiment. (auth)

18692 RELAXATION EFFECTS IN AN INITIALLY NON-MAXWELLIAN HIGH-TEMPERATURE θ-PINCH. House, L. L.; Swartztrauber, P. N. (High Altitude Observatory, Boulder, Colo.). Phys. Fluids, 10: 605-13(Mar. 1967).

Numerical solutions of coupled Fokker–Planck equations for electron and deuteron velocity distribution functions are used to investigate the non-Maxwellian conditions existing in fast magnetic compression theta-pinch experiments. Initial distribution functions are chosen to stimulate the post shock-heating phase of operation and the subsequent relaxation is followed. Because of rapid changes in the deuteron distribution function, the neutron yield is found to increase significantly with time although the mean energy changes little. Distortions at high and low velocities occur in the electron distribution resulting from interaction with the ions. These distortions produce two effects: (1) At short wavelength the x-ray flux is lower than that from a Maxwellian with the same mean energy; and (2) the edge of recombination continua of impurities are flattened relative to the spectrum produced by a Maxwellian distribution. The influence of the distorted x-ray spectrum upon standard absorber foil techniques for temperature measurement is considered. (auth)

18693 HELICAL CONFIGURATION PRODUCED IN GASEOUS MAGNETOPLASMAS BY THE GYRO-RESONANCE ABSORPTION OF MICROWAVES. Cherrington, B. E.; Goldstein, L. (Univ. of Illinois, Urbana). Phys. Fluids, 10: 613-29(Mar. 1967).

The nonuniform absorption of gyroresonant microwave energy by an electron gas is used to produce the helical configuration in gaseous magnetoplasmas. This configuration is examined both theoretically and experimentally. Stability criteria for the existence of the helix and the dependence of the properties of the helix on the plasma parameters are derived from the two-fluid magnetohydrodynamic equations for electrons and ions. The experimental examination of the instability is accomplished by the use of a suitable diagnostic procedure using low power ($\approx$ 50 μW), nonresonant microwave sensing signals. The detailed examination of the properties of the helical configuration verifies the theoretical predictions. Where it has been possible to measure the properties of the plasma discharge exactly, such as helix rotational frequency and discharge tube radius, excellent quantitative agreement between theory and experiment is found. Where it has only been possible to estimate the plasma parameters, such as electron temperature and longitudinal gradients, good qualitative agreement between theory and experiment is found. (auth)

18694 HIGH RESOLUTION PROBE FOR MEASURING THE ELECTRICAL CONDUCTIVITY OF A SHOCK-HEATED PLASMA. Williamson, J. H. (Univ. of British Columbia, Vancouver). Brit. J. Appl. Phys., 18: 317-24(Mar. 1967).

An external probe with spatial resolution (half width)/(plasma radius) of 0.13 has been developed. It uses the magnetic field deflection method of Lin, Resler and Kantrowitz but quadrupole coils are used to improve the resolution and to minimize self-shielding by the plasma. The theory is discussed and the device is shown to be superior to the rf excited probes for moving plasmas. Results are presented for Mach 12 shock waves in argon. (auth)

18695 INTENSIFICATION OF MAGNETIC FIELD IN PLAS MAS. Jaggi, R. K. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids, 10: 648-51(Mar. 1967).

An infinite plasma containing a uniform magnetic field is considered. Self-consistent solutions were found to two examples concerning the intensification of magnetic field by using magnetohydrodynamic equations with finite conductivity. In the first example, half of the infinite plasma moves perpendicular to the magnetic field and a finite amount of magnetic field is produced in the direction of motion of the plasma. When the velocity of the semi-infinite plasma is assumed to be independent of time, the magnetic field produced is proportional to $t^{\frac{1}{2}}$ and it is possible to produce any amount of magnetic field. However, the later situation is not realistic. In the second example, it is assumed that at $t = 0$ an external force along x axis acts in the region $-a \leq z \leq a$ and produces a component of the magnetic field along its direction of motion. The application of this example to the sun shows that large convective cells rising in the presence of the magnetic field of the sun can give rise to a strong magnetic field ($\sim 10^4$ G) in the direction of the convective motion. (auth)

18696 NUMERICAL CALCULATION OF THE RELAXATION OF AN ELECTRON GAS. Gu, Alston Lee-van (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 10: 673-5(Mar. 1967).

It is found that for disturbance at about 0.5 of the thermal speed approximately one self-collision time is enough for the distribution function to approach Maxwellian, and the time required increases rapidly as the disturbance moves to high velocity. (auth)

18697 INVARIANT OF THE HIGHER-ORDER CHEW–GOLDBERGER–LOW THEORY. Davidson, Ronald C. (Princeton Univ., N. J.). Phys. Fluids, 10: 669-70(Mar. 1967). (MATT-480).

In the context of the higher-order Chew–Goldberger–Low theory an expression for the magnetic moment invariant μ_j is obtained correct to first order in the expansion parameter. (auth)

18698 BINARY CORRELATIONS IN A STABLE HOMOGENEOUS PLASMA. Barrett, T. B.; Pytte, A.; Wang, C. Y. (Dartmouth Coll., Hanover, N. H.). Phys. Fluids, 10: 671(Mar. 1967).

It is shown that the general pair correlation function of Balescu and Taylor reduces directly to the correct expression in the case of equilibrium. (auth)

18699 EFFECTS OF A DENSITY GRADIENT ON THE MAGNETO-KERR EFFECT AT THE BOUNDARY OF A COLLISIONAL PLASMA. Heckenberg, N. R.; Robinson, L. C.; Rothman, G. P. (Univ. of Sydney). Phys. Fluids, 10: 680-2(Mar. 1967).

Results are presented of calculations showing the effects of collision frequency and surface-density gradient on the polarization of microwaves reflected from a plasma surface. Experimental observations are compared with these results and estimates made of collision frequency and density gradient. (auth)

18700 STUDIES OF DECAYING HELIUM PLASMAS. Gerber, R. A.; Sauter, G. F.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Physica, 32: 2173-91(Nov.-Dec. 1966).

Simultaneous measurements of the time dependence of the intensities of spectral lines and bands and of the number density of atomic and molecular ions in decaying helium plasmas are reported. The validity and reliability of mass-spectrometric probing of a decaying plasma is checked by comparing the values obtained for the ambipolar diffusion coefficient of He^+ and He_2^+ with those measured by means of other techniques. The results showed that, in the wavelength region of 3000 to 7000 Å, the spectral line emission by a decaying helium plasma is a consequence of the collisional radiative recombination process $He^+ + 2e \rightarrow He^* + e \rightarrow He + e + h\nu$. No evidence was found for the occurrence of the dissociative recombination process $He_2^+ + e \rightarrow He^* + He \rightarrow 2He + h\nu$. The spectral band emission was determined to be caused by the collisional radiative recombination process $He_2^+ + e + X \rightarrow He_2^* + X \rightarrow 2He + X + h\nu$, where the identity of X is as yet not definitely established, but it is not a helium atom in the ground state. (auth)

18701 STUDIES OF DECAYING PLASMAS PRODUCED IN NEON AND HELIUM–NEON MIXTURES. Sauter, G. F.; Gerber, R. A.; Oskam, H. J. (Univ. of Minnesota, Minneapolis). Physica, 32: 1921-37(Nov.-Dec. 1966).

Simultaneous measurements of the time dependence of the intensities of spectral lines and of the number density of atomic and molecular ions in decaying plasmas produced in neon and helium–neon mixtures are reported. The measurements in neon resulted in the mobility value, $\mu_0(Ne^+) = 4.0\ cm^2/V\ sec$, at a gas temperature of 335°K, while the frequency of conversion of Ne^+ into Ne_2^+ was found to be $\nu_{conv} = 52\ p_0^2\ sec^{-1}$. A study of the time dependences, during the neon afterglow, of the intensity of spectral lines originating from transitions from the 4d levels strongly indicates that these levels are mainly populated by a recombination process involving Ne^+. Analogous studies of the behavior of spectral lines originating from transitions from the 2p and 3p levels show that these energy levels are mainly populated by the dissociative recombination process $Ne_2^+ + e \rightarrow Ne^* + Ne \rightarrow 2Ne + h\nu$. Preliminary studies on decaying plasmas produced in a helium–neon mixture confirmed the occurrence of the processes $He_2^+ + Ne \rightarrow Ne^+ + 2He$ and $Ne^+ + 2He \rightarrow (HeNe)^+ + He$ as previously postulated by Oskam. Moreover, these studies indicated the occurrence of the conversion process $(HeNe)^+ + Ne + He \rightarrow Ne_2^+ + 2He$. (auth)

18702 FREQUENCY DEPENDENCE OF PLASMA PARAMETERS IN POSITIVE COLUMN WITH NON-HOMOGENEOUS HF FIELDS. Grigorov, G.; Popov, G.; Drazheva, L. (Sofia Univ.). Compt. Rend. Acad. Bulg. Sci., 18: 413-16(1965).

A discharge was produced in dry air under a pressure of 0.3 torr. The parameters of the plasma were measured with a Langmuir probe. The variation of the plasma parameters as a function of the frequency of the hf field is conditioned by the change in the load diffusion in that field. Graphs showing the results are presented. (M.O.W.)

18703 INTERACTION OF IONIC CYCLOTRON WAVES WITH HIGH-FREQUENCY OSCILLATIONS OF A PLASMA. Fedorchenko, V. D.; Muratov, V. I.; Rutkevich, B. N. Zh. Tekh. Fiz., 36: 1964-70(Nov. 1966). (In Russian).

A continuation is presented of earlier work on the nonlinear interaction of waves in plasmas. Plasmas were excited in krypton, air, or helium at pressures of the order of 10^{-4} mm Hg within a 9-cm-diameter 100-cm-long metal tube in a longitudinal magnetic field of from 0.4 to 1.0 kOe by a 2-cm-diameter 50-cm-long 200 to 250-mA beam of 160-eV electrons which was received by a floating collector. Under these conditions oscillations with a frequency of about 12 kHz developed in the plasma. These oscillations were investigated with the aid of adjustable electric probes, a magnetic probe, and an electron beam traversing the chamber parallel to and 2 cm from its axis, and it is concluded that they represent helical ionic cyclotron waves with the propagation vector almost perpendicular to the magnetic field. High-frequency power from an external oscillator with a frequency near the electron Langmuir frequency of about 0.5 kMHz or near the ion Larmor frequency of about 1.4 kMHz was injected at one end of the discharge chamber and the high-frequency signal from the plasma was observed with the aid of an electric probe. When the high-frequency power was turned on the amplitude of the ionic cyclotron oscillations increased and there appeared oscillations at frequencies equal to the sum and the difference of the frequencies of the high-frequency oscillations and the ionic cyclotron oscillations. The low-frequency satellite was stronger than the high-frequency one. In a brief review of the present and the earlier work, it is noted that in all the cases investigated of interaction between low- and high-frequency oscillations in plasmas, there appeared oscillations at the combination frequencies and that, in accord with the concept of plasmon breakup and combination, the low-frequency oscillations were strengthened or weakened by the presence of the high-frequency oscillations according as the low- or high-frequency satellite was the stronger. The behavior of the combination-frequency oscillations is sensitive to turbulence of the plasma and it is suggested that study of the combination-frequency oscillations may prove to be useful in the investigation of plasma turbulence. (ATD)

18704 NONLINEAR INTERACTION OF WAVES IN A PLASMA IN A STRONG EXTERNAL MAGNETIC FIELD. Tsytovich, V. N.; Shvartsburg, A. B. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1915-42(Nov. 1966). (In Russian).

The following discussions are presented on nonlinear interactions of waves in magnetized plasmas: (1) nonlinear interaction; (2) nonlinear scattering; (3) induced scattering of high frequency waves on ions, (a) scattering through virtual plasma waves of plasma waves and extraordinary waves into plasma waves and extraordinary waves at the zeroth harmonic; (4) scattering through plasma waves at the first harmonics; (5) induced nonlinear scattering of waves on ions through virtual quasitransverse waves; (6) induced scattering of low frequency plasma waves on ions; (7) induced scattering of high frequency waves on electrons; and (8) decay processes, (a) decay of plasma waves into low-frequency waves, (b) decay of plasma waves into transverse waves and vice versa, and (c) decay of transverse waves into transverse waves. The calculations are based on a modification for the case of weakly damped waves in a magnetized plasma under conditions of weak space dispersion. Three types of waves are discussed: plasma waves, ordinary waves, and extraordinary waves. Under certain conditions the cross section for scattering on ions can exceed that for scattering on electrons. The interaction of waves propagating nearly perpendicularly to the magnetic field can somewhat exceed that of waves propagating parallel to the field. Nonlinear scattering involving virtual waves of different types is discussed and it is shown that induced scattering at the first harmonics of the ion Larmor frequency can exceed that at the zeroth harmonic. The possibility of nonlinear amplification of plasma oscillations at frequencies near the electron cyclotron resonance is discussed. Scattering on ions through virtual quasitransverse waves can exceed that through quasi-longitudinal waves; the conditions that this be the case are found, and the induced nonlinear scattering on ions of low-frequency plasma waves is discussed. The scattering of waves on the plasma electrons is also discussed. Probabilities are given for a number of decay processes, and equations are presented in an appendix with which probabilities of other decay processes can be calculated. (ATD)

18705 ELECTRICAL METHOD FOR CUTTING OFF A PLASMA STREAM. Zykov, V. M.; Fedyanin, O. I. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1990-4(Nov. 1966). (In Russian).

The performance of an electrostatic plasma gate consisting of a number of 0.12-mm-thick 20-mm-long stainless steel plates mounted parallel on a 2-mm spacing with alternate plates oppositely charged was investigated. The gate is intended for use in a plasma purification system. When no voltage was applied to the gate its transparency increased with increasing strength of the longitudinal magnetic field; in a 2-kOe field the transparency of the gate was 0.85, which is close to the geometric value. When a potential of 100 V was applied to the gate, its transparency to a plasma with a maximum density of $10^{11}\ cm^{-3}$ was 0.04, and at a potential of 200 V its transparency to a $10^{12}\ cm^{-3}$ plasma was 0.01. The gate was also tested with 100-V square pulses, and it was found to be possible to cut off a selected portion of the plasma burst. It is suggested that the operation of the gate involves separation of the plasma into electron and ion components in the strong electric field. (ATD)

18706 SURFACE WAVES IN A CURRENT-CARRYING PLASMA OF FINITE RADIUS. Makhan'kov, V. G. Zh. Tekh. Fiz., 36: 1752-7(Oct. 1966). (In Russian).

Stability with respect to axially symmetric surface waves is discussed for a uniform quasi-neutral plasma cylinder of finite radius carrying a uniform beam of the same radius as relativistic electrons. The dielectric tensor is derived from Maxwell's equations and the hydrodynamic equations, linearized for an axially symmetric perturbation propagating both axially and azimuthally. Boundary conditions for the electromagnetic fields at the boundary of the plasma are derived by integrating the curl of the magnetic field across the transition layer at the boundary, the thickness of which is assumed to be small compared with the wavelength of the perturbation. The boundary condition thus obtained for the azimuthal component of the magnetic field differs from the usual one in that it contains a term proportional to the radial component of the electric field. These boundary conditions are valid when the Debye radius is much smaller than the thickness of the transition layer. The dispersion equation is derived and its roots are discussed in several limiting cases that permit simplification. When the Langmuir frequencies of the plasma and the beam differ greatly, perturbations with frequencies lower than the lower of the two Langmuir frequencies are unstable. When the beam Langmuir frequency is the lower, this instability is aperiodic and its increment is smaller by a factor $\sqrt{2}$ than that of the aperiodic instability of the corresponding unbounded system. When the axial component of the propagation vector is small, the increment of azimuthally symmetric surface waves is exponentially small, and such waves propagating only in the azimuthal direction do not exist. For transverse waves with transverse wavelength small compared with the radius of the plasma cylinder, the present dispersion equation gives results similar to those previously derived by the author from the usual boundary conditions. (ATD)

18707 EMISSION FROM A PLANE OF A COLD COMPENSATED ELECTRON STREAM. Smirnov, V. M. (Moscow Engineering Physics Inst.). Zh. Tekh. Fiz., 36: 1872-4(Oct. 1966). (In Russian).

M. V. Konyukov earlier solved the problem of the one-dimensional nonsteady motion of a cold electron plasma on a uniform background of positive (ionic) space charge. A graphical repre-

sentation is presented to assist one to visualize the different possible solutions to that problem for the case of a stream of electrons issuing from a plane emitter. It is shown that the curve representing the electric field as a function of the electron velocity rotates counterclockwise at the Langmuir frequency while undergoing a simultaneous forward displacement. Different features of this curve are related to different characteristics of the behavior of the cold electron plasma. It is shown that by applying a rather weak alternating field of the Langmuir frequency at the plane of the emitter one can excite long wavelength oscillations in the electron stream, which give rise to high instantaneous potentials that can be employed for periodically accelerating or cutting off rather fast particles. (ATD)

18708 ION–ELECTRON HYBRID RESONANCE WITH PARTIAL PROPAGATION ALONG THE MAGNETIC FIELD. Oakes, M. E.; Schlueter, H.; Wheatley, B. N. (Univ. of Texas, Austin). Ann. Phys. (N. Y.), 41: 339-46(Feb. 2, 1967). (TID–22817).

The complex index of refraction near the ion–electron hybrid frequency is calculated for a plasma of finite length using a two-fluid model with collision terms. It is found that a simplified approach assuming only the fundamental longitudinal mode of oscillation correctly describes the small effect of finite plasma length on the resonant frequency for plasma parameters typical of recent observations. Large effects are predicted for other conditions, in particular for heavier gases. (auth)

18709 CURRENT DISTRIBUTION ALONG THE ELECTRODES OF A COAXIAL PLASMA INJECTOR. Skvortsov, Yu. V. Zh. Tekh. Fiz., 36: 1808-15(Oct. 1966). (In Russian).

The azimuthal component of the magnetic field between the electrodes of a coaxial plasma gun was measured at different points along the axis, and at different times after initiation of the discharge. The plasma gun was 39-cm long and the radii of the annular space between the copper electrodes were 5.5 and 2.5 cm. Hydrogen was admitted through a ring of openings in the inner electrode located 14 cm from the flange and 25 cm from the mouth of the gun. The magnetic probes were introduced through slots in the outer electrode. The gun was powered by the 20-kV discharge of a 33.5-μF capacitor. The gun was operated under two different conditions: in the "high-pressure regime" the hydrogen pressure in the 1 cm^3 chamber of the fast electrodynamic valve was 4 atm and the discharge was delayed for 150 microsec after admission of the gas; in the "low-pressure regime," these quantities were 1 atm and 50 μsec. The total discharge current was measured with a Rogovskii belt, and the electrode potential differences were measured with the aid of an ohmic voltage divider. The results of the measurements are presented graphically; in particular, the longitudinal distribution of the azimuthal magnetic field is given for each regime at seven different times, between 0.55 and 9 μsec after initiation of the discharge. The azimuthal magnetic field distributions show that during acceleration of the plasma the current is not confined to a thin sheet, as is frequently assumed, but is distributed along the length of the gun, and that closed current loops appear in the plasma in the early stages of acceleration. Possible reasons for the observed behavior of the accelerating plasma are discussed at some length. (ATD)

18710 FLUTE OSCILLATIONS OF A RAREFIED PLASMA IN PRESENCE OF UNCOMPENSATED SPACE CHARGE. Timofeev, A. V. Zh. Tekh. Fiz., 36: 1787-99(Oct. 1966). (In Russian).

Fluted oscillations are discussed for a rarefied plasma in which the ion Larmor radius is much smaller than the ion Debye radius and there is a large uncompensated space charge. From Poisson's equation and the hydrodynamic equations of continuity, linearized for small perturbations of the particle densities, there is derived a differential equation for the self-consistent perturbation of the electric potential. If the space charge density is sufficiently high this equation has singular points where the particle velocity becomes equal to the phase velocity of the waves. The equation is modified in the neighborhood of the singular points by inclusion of the effect of the finite value of the Larmor radius. It is found that if the electric field due to the uncompensated space charge is sufficiently strong and varies linearly with distance, the modified equation may have no localized eigenfunctions. The initial value problem for this case is solved by a Laplace transformation technique, and it is found that the amplitude of an arbitrary perturbation decreases with time t, being proportional to exp $(-at^3)/t^3$. (ATD)

18711 CHARACTERISTICS OF INTERACTION OF FAST PLASMA WITH A TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. Zh. Tekh. Fiz., 36: 1779-86(Oct. 1966). (In Russian).

The entrapment of hydrogen plasma bursts from a 17.5-cm-long 7.2-cm-diameter coaxial plasma gun powered by the 15-kV discharge of a 15-μF capacitor was investigated in a transverse magnetic field of strength up to 0.2 weber/m^2. The plasmas travelled from the gun to the transverse magnetic field through an 80-cm-long tube of glass or metal. The behavior of the plasmas was observed with both electric and magnetic probes and with 4-mm microwaves, and the composition of the plasma that traversed the magnetic field was recorded with a parabola-type (Thompson) mass spectrometer. The plasmas from the coaxial gun had two components: a fast component with a velocity of 7×10^5 m/sec and a relatively low density, and a slow component with a velocity of 1.5×10^5 m/sec and a density exceeding 7×10^{13} cm^{-3}. The fast component was entrapped by very weak fields (0.01 to 0.02 weber/m^2), and it is concluded that it would be very difficult to inject these fast plasmas transversely into a magnetic trap because they would become entrapped in the fringe field. When the drift tube was of glass the slow plasmas were also rather rapidly entrapped and did not reach the region of strong magnetic field. When the drift tube was of metal, however, the slow plasma component tended to penetrate the transverse magnetic field and could be entrapped in a region of high field strength. The difference between the behaviors of the plasmas in the glass and metal drift tubes is ascribed to short circuiting of the plasma polarization by the walls of the metal drift tube and consequent deceleration of the plasma. It is concluded that for transverse injection of plasma into a magnetic trap one should select an injector that produces slow dense plasmas. (ATD)

18712 HELIUM DISCHARGE POSITIVE COLUMN IN A STRONG MAGNETIC FIELD. Nedospasov, A. V.; Sobolev, S. S. Zh. Tekh. Fiz., 36: 1758-67(Oct. 1966). (In Russian).

In order to investigate the transition of the positive column of a gas discharge in a magnetic field from the condition of current-convective instability that obtains at magnetic field strengths close to a critical value to the turbulent condition that prevails at much higher magnetic field strengths, the authors have recorded with probes the oscillations in the positive column of a hot cathode helium discharge in a 3.1-cm-diameter 180-cm-long tube in magnetic fields up to 6 kOe extending over 120 cm of the length of the discharge tube. Three 12 mm long 0.3 mm diameter molybdenum probes were mounted at different points on the axis of the discharge tube, and two similar probes were mounted at different distances from the axis opposite two of the axial probes. The spectra of the signals from the probes and the correlation functions of the signals from different pairs of probes were recorded. Twenty-six of the recorded spectra and correlation functions are presented graphically and are discussed at some length. Three types of oscillations were distinguished: current-convective oscillations with a discrete spectrum, which appeared as expected at the critical magnetic field strength and behaved in accordance with the theory; low frequency oscillations with frequencies of a few kilohertz associated with propagation of waves from the axis to the wall of the discharge tube, the propagation velocity being 3×10^5 cm/sec at a magnetic field strength of 5.6 kOe; and oscillations with frequencies of several tens of kilohertz, which first appeared when the magnetic field was slightly inclined to the axis of the discharge tube and was of such a strength that the ion Larmor frequency was approximately equal to the ion collision frequency. Possible causes of the different oscillations are discussed. (ATD)

18713 IONIC SOUND OSCILLATIONS IN A DENSE PLASMA. Petviashvili, V. I. Zh. Tekh. Fiz., 36: 1737-9(Oct. 1966). (In Russian).

An extension is presented of earlier work in which an equation was derived for the spectral density of the ionic sound excited by an electron current in a completely ionized plasma whose electron temperature is much higher than its ion temperature. The effect of ion viscosity was neglected in the earlier work. The effect of ion viscosity on waves with propagation velocities that are much higher than the ion thermal velocities is calculated with the aid of Vlasov's equation, and it is found that the effect of ion viscosity can be significant even when the wave frequency greatly exceeds the ion collision frequency. The effect of ion viscosity on the spectral density of ionic sound is calculated, and it is concluded that the spectral density vanishes at both low and high frequencies. (ATD)

18714 THEORY OF EXCITATION AND PROPAGATION OF ELECTROMAGNETIC WAVES IN A WEAKLY TURBULENT PLASMA. Tsytovich, V. N.; Shvartsburg, A. B. Zh. Tekh. Fiz., 36: 1896-1900(Oct. 1966). (In Russian).

The hydrodynamic equations are used for the plasma electrons to discuss high-frequency perturbations of a weakly turbulent cold plasma. An expression containing terms up to the third degree in the electric field strength is obtained for the current in the plasma. It is assumed that the random electric field due to the turbulence is large compared with the perturbation field, and only terms linear in the latter are retained. A formula is given for the dielectric tensor of a plasma containing both longitudinal and transverse

turbulence. The imaginary parts of the dielectric tensor lead to the known decay instabilities. New types of instabilities are found, which cannot be described in the random-phase approximation. Conditions for the appearance of these instabilities in a plasma containing anisotropic longitudinal or transverse turbulence are found and expressions for their increments are derived. The double refraction of high-frequency waves in a plasma containing anisotropic longitudinal turbulence is discussed. The double refraction in a turbulent plasma may prove useful in plasma diagnostics. (ATD)

18715 BEHAVIOR OF A SUPERHIGH-FREQUENCY DISCHARGE NEAR THE PLASMA RESONANCE. Maksimov, A. I. (Inst. of Chemical Physics, Moscow). Zh. Tekh. Fiz., 36: 1894-6(Oct. 1966). (In Russian).

The intensity of the He 4713 Å line and the electron density in 3-kMHz discharges in helium were recorded as functions of the superhigh-frequency power and helium pressure. The intensity increased approximately linearly with the power for low powers and at helium pressures below 10 mm Hg this linear increase persisted to the highest power investigated (50 W). At higher helium pressures, however, the intensity increased suddenly as the power was increased through a critical value. In some cases the line intensity passed through a maximum as the power was further increased. When the line intensity increased rapidly, the electron density decreased rapidly and, as a function of applied power, passed through a sharp minimum. The electron density at the minimum was close (considering the experimental error) to the value at which the plasma frequency becomes equal to the applied frequency. The observed phenomena are ascribed to the effects of resonance between the plasma frequency and the applied frequency, the enhanced excitation of the He 4713 line being ascribed to increase of the energy of the plasma electrons as a result of the resonance effects. The resonance phenomena were not observed at helium pressures below 10-mm Hg because at those pressures the electron density necessary for resonance is reached only at higher powers than were available. (ATD)

18716 ISOLATION AND AMPLIFICATION OF THE DIFFERENCE FREQUENCY IN A PLASMA-BEAM SYSTEM. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Radiotekh. Elektron., 11: 1325-7(July 1966). (In Russian).

A. M. Fedorchenko examined a method of difference-frequency generation in a plasma-beam system where two electromagnetic waves propagated in the same direction (Radiotekhn. i Elektron., 11: 693(1966)). The present article considers the same system in which the two waves propagate in opposite directions. The second approximation is used in the analysis, which proves that the system can be used for generation of the difference frequency and also for SHF mixers. In principle, a solid-state plasma is also applicable; it would have an advantage of higher attainable frequency and a disadvantage of short relaxation time (10^{-10} to 10^{-12} sec). (ATD)

18717 RADIATION FROM AN ISOTHERMAL HYDROGEN PLASMA AT TEMPERATURES UP TO 40,000°K. Lasher, L. E.; Wilson, K. H.; Greif, R. (Lockheed Palo Alto Research Lab., Calif.). J. Quant. Spectros. Radiative Transfer, 7: 305-22(Mar.-Apr. 1967).

The energy radiated from an isothermal hydrogen plasma was calculated considering both line and continuum emission processes. The principal line broadening mechanism for the plasma conditions considered was electrons interacting with the radiating system. Detailed line profiles were used for the lower members of the Lyman and Balmer series. The higher members were treated as having dispersion profiles. The continuum radiation was calculated using the well known expressions for the continuum absorption coefficients. Results were obtained for temperatures between 10^4 and 4×10^4°K, pressures between 10^{-1} and 10^1 atm, and plasma thicknesses between 10^{-1} and 10^1 cm. (auth)

18718 REFRACTION AND FOCUSING OF SPHERICAL ELECTROMAGNETIC WAVE INCIDENT TO A WEAKLY NONUNIFORM PARABOLIC PLASMA LAYER. Orlov, Yu. I. (Moscow Inst. of Power Engineering). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 30-9(1967). (In Russian).

The method of beam optics is applied to the problem of the spherical electromagnetic wave incidence upon a parabolic plasma layer. The features of the ray ensemble, the field, and the refractive structure owing to the curvature of the incident wave front are analyzed. The special points of the refraction are determined and investigated. The plane of the characteristic parameters of the system is divided into the regions corresponding to the different types of refraction. The evolution is considered, of the ray picture and of refraction connected with the change of the source position, as well as the position and the maximum magnitude of the electronic density. (auth)

18719 KINETIC EQUATIONS FOR RADIATION PROCESSES IN MAGNETIZED PLASMA. Tskhakaya, D. D. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izv. Vyssh. Ucheb. Zaved. Radiofiz., 10: 18-29(1967). (In Russian).

Kinetic equations are derived for electrons and photons in a uniform plasma subjected to a strong magnetic field. The radiation collisions are assumed to be the principal interaction mechanism. (auth)

18720 THEORY OF SYNCHROTRON RADIATION IN MAGNETOACTIVE PLASMA. Kaplan, S. A.; Trakhtengerts, V. Yu. (Gorkii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 14-18(1967). (In Russian).

An expression is obtained for the intensity of the synchrotron radiation of a relativistic electron moving at an arbitrary angle in an anisotropic medium. The case when $n_j\beta < 1$ is considered in detail and the case when $n_j\beta > 1$ (n_j is the refractive index, $v = \beta c$ is the total electron velocity) is discussed. For the synchrotron radiation in a magnetoactive plasma the anisotropy influence is essential only in the close vicinity of the plasma frequency. (auth)

18721 SCATTERING AND TRANSFORMATION OF WAVES IN A MAGNETOACTIVE PLASMA. Sitenko, A. G.; Kirochkin, Yu. A. (Inst. of Physics, Kiev). Usp. Fiz. Nauk, 89: 227-58 (June 1966). (In Russian).

A theoretical investigation was made of the electrodynamic properties of a homogeneous magnetoactive plasma. The propagation of waves and excitation of waves by external currents in such a plasma are analyzed on the basis of kinetic theory. The fluctuations of different physical quantities characterizing the state of the magnetoactive plasma are investigated, as are processes of the scattering of waves and their mutual transformation by fluctuations in the plasma. The section headings are: (1) Electrodynamic properties of a magnetoactive plasma (the dielectric tensor and its connection with the particle distribution, the dispersion equation, wave polarization, and energy flux density). (2) Waves in a magnetoactive plasma (high-frequency and low-frequency waves). (3) Excitation of waves in a magnetoactive plasma by external current. (4) Fluctuations in a magnetoactive plasma (collective coherent fluctuations and their correlation functions, effective temperature, fluctuation in equilibrium and nonequilibrium plasmas). (5) Scattering and transformation of electromagnetic waves in a magnetoactive plasma (excitation of high-frequency waves, scattering and transformation of electromagnetic waves by incoherent fluctuations, scattering and transformation by coherent fluctuations, scattering and transformation by Langmuir fluctuations, and scattering and transformation by low-frequency fluctuations). (6) Scattering and transformation of Langmuir waves in a magnetoactive plasma (by incoherent and coherent fluctuations). (7) Transformation of low frequency waves by Langmuir fluctuations in the magnetoactive plasma. (ATD)

18722 QUASI-UNIDIMENSIONAL FLOW IN A PLASMA ACCELERATOR WITH PROGRESSIVE WAVES. Peyret, Roger (Univ., Paris). J. Mecan., 5: 471-515(Dec. 1966). (In French).

The flow of a perfect compressible electrically conducting fluid in an accelerator with progressive waves was studied. The general bidimensional equations controlling such a flow are first given; then the equations of the unidimensional approximation are resolved by the classical method of small perturbations. The solution obtained can not represent the flow at a great distance from the accelerator inlet, and another asymptotic method, the method of multiple coordinates, is then used. The flow caused by the field created by a current ring is calculated to illustrate the extremity effects phenomena. (tr-auth)

18723 THEORY OF CONDUCTIVITY OF ELECTROLYTES AND WEAKLY-IONIZED PLASMA. I. Kremp, D. (Univ., Rostock, Ger.). Ann. Phys. (7), 18: 237-45(Nov. 1966). (In German).

The pair distribution and conductance of electrolyte solutions and weakly ionized plasmas were calculated on the basic of equations given in an earlier paper. The conductance was calculated up to terms of the order $\varkappa^2 a^2 b^2$ and $\varkappa^2 a^2 b^2 \ln \varkappa a$. (auth)

18724 ELECTRON VELOCITY-DISTRIBUTION FUNCTIONS FOR FORCE-FREE OR PARTIALLY FORCE-FREE MAGNETIC FIELDS. Moratz, E.; Richter, E. W. (Univ., Kiel). Z. Naturforsch., 21a: 1963-6(Nov. 1966). (In German).

Based on the Vlasov equation, a method is derived to deliver velocity distributions in the case of a one-component plasma which produces a force-free, or in part, force-free magnetic field. This formalism is applied to simple fields of the type $\Phi = (H_x(z), H_y(z), 0)$. (auth)

18725 RANKINE–HUGONIOT CALCULATIONS FOR NONEQUILIBRIUM PLASMA. Artmann, J. (Deutsche Versuchsan-

sentation is presented to assist one to visualize the different possible solutions to that problem for the case of a stream of electrons issuing from a plane emitter. It is shown that the curve representing the electric field as a function of the electron velocity rotates counterclockwise at the Langmuir frequency while undergoing a simultaneous forward displacement. Different features of this curve are related to different characteristics of the behavior of the cold electron plasma. It is shown that by applying a rather weak alternating field of the Langmuir frequency at the plane of the emitter one can excite long wavelength oscillations in the electron stream, which give rise to high instantaneous potentials that can be employed for periodically accelerating or cutting off rather fast particles. (ATD)

18708 ION–ELECTRON HYBRID RESONANCE WITH PARTIAL PROPAGATION ALONG THE MAGNETIC FIELD. Oakes, M. E.; Schlueter, H.; Wheatley, B. N. (Univ. of Texas, Austin). Ann. Phys. (N. Y.), 41: 339-46(Feb. 2, 1967). (TID-22817).

The complex index of refraction near the ion–electron hybrid frequency is calculated for a plasma of finite length using a two-fluid model with collision terms. It is found that a simplified approach assuming only the fundamental longitudinal mode of oscillation correctly describes the small effect of finite plasma length on the resonant frequency for plasma parameters typical of recent observations. Large effects are predicted for other conditions, in particular for heavier gases. (auth)

18709 CURRENT DISTRIBUTION ALONG THE ELECTRODES OF A COAXIAL PLASMA INJECTOR. Skvortsov, Yu. V. Zh. Tekh. Fiz., 36: 1808-15(Oct. 1966). (In Russian).

The azimuthal component of the magnetic field between the electrodes of a coaxial plasma gun was measured at different points along the axis, and at different times after initiation of the discharge. The plasma gun was 39-cm long and the radii of the annular space between the copper electrodes were 5.5 and 2.5 cm. Hydrogen was admitted through a ring of openings in the inner electrode located 14 cm from the flange and 25 cm from the mouth of the gun. The magnetic probes were introduced through slots in the outer electrode. The gun was powered by the 20-kV discharge of a 33.5-μF capacitor. The gun was operated under two different conditions: in the "high-pressure regime" the hydrogen pressure in the 1 cm^3 chamber of the fast electrodynamic valve was 4 atm and the discharge was delayed for 150 microsec after admission of the gas; in the "low-pressure regime," these quantities were 1 atm and 50 μsec. The total discharge current was measured with a Rogovskii belt, and the electrode potential differences were measured with the aid of an ohmic voltage divider. The results of the measurements are presented graphically; in particular, the longitudinal distribution of the azimuthal magnetic field is given for each regime at seven different times, between 0.55 and 9 μsec after initiation of the discharge. The azimuthal magnetic field distributions show that during acceleration of the plasma the current is not confined to a thin sheet, as is frequently assumed, but is distributed along the length of the gun, and that closed current loops appear in the plasma in the early stages of acceleration. Possible reasons for the observed behavior of the accelerating plasma are discussed at some length. (ATD)

18710 FLUTE OSCILLATIONS OF A RAREFIED PLASMA IN PRESENCE OF UNCOMPENSATED SPACE CHARGE. Timofeev, A. V. Zh. Tekh. Fiz., 36: 1787-99(Oct. 1966). (In Russian).

Fluted oscillations are discussed for a rarefied plasma in which the ion Larmor radius is much smaller than the ion Debye radius and there is a large uncompensated space charge. From Poisson's equation and the hydrodynamic equations of continuity, linearized for small perturbations of the particle densities, there is derived a differential equation for the self-consistent perturbation of the electric potential. If the space charge density is sufficiently high this equation has singular points where the particle velocity becomes equal to the phase velocity of the waves. The equation is modified in the neighborhood of the singular points by inclusion of the effect of the finite value of the Larmor radius. It is found that if the electric field due to the uncompensated space charge is sufficiently strong and varies linearly with distance, the modified equation may have no localized eigenfunctions. The initial value problem for this case is solved by a Laplace transformation technique, and it is found that the amplitude of an arbitrary perturbation decreases with time t, being proportional to exp $(-at^2)/t^2$. (ATD)

18711 CHARACTERISTICS OF INTERACTION OF FAST PLASMA WITH A TRANSVERSE MAGNETIC FIELD. Demidenko, I. I.; Lomino, N. S.; Padalka, V. G. Zh. Tekh. Fiz., 36: 1779-86(Oct. 1966). (In Russian).

The entrapment of hydrogen plasma bursts from a 17.5-cm-long 7.2-cm-diameter coaxial plasma gun powered by the 15-kV discharge of a 15-μF capacitor was investigated in a transverse magnetic field of strength up to 0.2 weber/m^2. The plasmas travelled from the gun to the transverse magnetic field through an 80-cm-long tube of glass or metal. The behavior of the plasmas was observed with both electric and magnetic probes and with 4-mm microwaves, and the composition of the plasma that traversed the magnetic field was recorded with a parabola-type (Thompson) mass spectrometer. The plasmas from the coaxial gun had two components: a fast component with a velocity of 7×10^5 m/sec and a relatively low density, and a slow component with a velocity of 1.5×10^5 m/sec and a density exceeding 7×10^{13} cm^{-3}. The fast component was entrapped by very weak fields (0.01 to 0.02 weber/m^2), and it is concluded that it would be very difficult to inject these fast plasmas transversely into a magnetic trap because they would become entrapped in the fringe field. When the drift tube was of glass the slow plasmas were also rather rapidly entrapped and did not reach the region of strong magnetic field. When the drift tube was of metal, however, the slow plasma component tended to penetrate the transverse magnetic field and could be entrapped in a region of high field strength. The difference between the behaviors of the plasmas in the glass and metal drift tubes is ascribed to short circuiting of the plasma polarization by the walls of the metal drift tube and consequent deceleration of the plasma. It is concluded that for transverse injection of plasma into a magnetic trap one should select an injector that produces slow dense plasmas. (ATD)

18712 HELIUM DISCHARGE POSITIVE COLUMN IN A STRONG MAGNETIC FIELD. Nedospasov, A. V.; Sobolev, S. S. Zh. Tekh. Fiz., 36: 1758-67(Oct. 1966). (In Russian).

In order to investigate the transition of the positive column of a gas discharge in a magnetic field from the condition of current-convective instability that obtains at magnetic field strengths close to a critical value to the turbulent condition that prevails at much higher magnetic field strengths, the authors have recorded with probes the oscillations in the positive column of a hot cathode helium discharge in a 3.1-cm-diameter 180-cm-long tube in magnetic fields up to 6 kOe extending over 120 cm of the length of the discharge tube. Three 12 mm long 0.3 mm diameter molybdenum probes were mounted at different points on the axis of the discharge tube, and two similar probes were mounted at different distances from the axis opposite two of the axial probes. The spectra of the signals from the probes and the correlation functions of the signals from different pairs of probes were recorded. Twenty-six of the recorded spectra and correlation functions are presented graphically and are discussed at some length. Three types of oscillations were distinguished: current-convective oscillations with a discrete spectrum, which appeared as expected at the critical magnetic field strength and behaved in accordance with the theory; low frequency oscillations with frequencies of a few kilohertz associated with propagation of waves from the axis to the wall of the discharge tube, the propagation velocity being 3×10^5 cm/sec at a magnetic field strength of 5.6 kOe; and oscillations with frequencies of several tens of kilohertz, which first appeared when the magnetic field was slightly inclined to the axis of the discharge tube and was of such a strength that the ion Larmor frequency was approximately equal to the ion collision frequency. Possible causes of the different oscillations are discussed. (ATD)

18713 IONIC SOUND OSCILLATIONS IN A DENSE PLASMA. Petviashvili, V. I. Zh. Tekh. Fiz., 36: 1737-9(Oct. 1966). (In Russian).

An extension is presented of earlier work in which an equation was derived for the spectral density of the ionic sound excited by an electron current in a completely ionized plasma whose electron temperature is much higher than its ion temperature. The effect of ion viscosity was neglected in the earlier work. The effect of ion viscosity on waves with propagation velocities that are much higher than the ion thermal velocities is calculated with the aid of Vlasov's equation, and it is found that the effect of ion viscosity can be significant even when the wave frequency greatly exceeds the ion collision frequency. The effect of ion viscosity on the spectral density of ionic sound is calculated, and it is concluded that the spectral density vanishes at both low and high frequencies. (ATD)

18714 THEORY OF EXCITATION AND PROPAGATION OF ELECTROMAGNETIC WAVES IN A WEAKLY TURBULENT PLASMA. Tsytovich, V. N.; Shvartsburg, A. B. Zh. Tekh. Fiz., 36: 1896-1900(Oct. 1966). (In Russian).

The hydrodynamic equations are used for the plasma electrons to discuss high-frequency perturbations of a weakly turbulent cold plasma. An expression containing terms up to the third degree in the electric field strength is obtained for the current in the plasma. It is assumed that the random electric field due to the turbulence is large compared with the perturbation field, and only terms linear in the latter are retained. A formula is given for the dielectric tensor of a plasma containing both longitudinal and transverse

turbulence. The imaginary parts of the dielectric tensor lead to the known decay instabilities. New types of instabilities are found, which cannot be described in the random-phase approximation. Conditions for the appearance of these instabilities in a plasma containing anisotropic longitudinal or transverse turbulence are found and expressions for their increments are derived. The double refraction of high-frequency waves in a plasma containing anisotropic longitudinal turbulence is discussed. The double refraction in a turbulent plasma may prove useful in plasma diagnostics. (ATD)

18715 BEHAVIOR OF A SUPERHIGH-FREQUENCY DISCHARGE NEAR THE PLASMA RESONANCE. Maksimov, A. I. (Inst. of Chemical Physics, Moscow). Zh. Tekh. Fiz., 36: 1894-6(Oct. 1966). (In Russian).

The intensity of the He 4713 Å line and the electron density in 3-kMHz discharges in helium were recorded as functions of the superhigh-frequency power and helium pressure. The intensity increased approximately linearly with the power for low powers and at helium pressures below 10 mm Hg this linear increase persisted to the highest power investigated (50 W). At higher helium pressures, however, the intensity increased suddenly as the power was increased through a critical value. In some cases the line intensity passed through a maximum as the power was further increased. When the line intensity increased rapidly, the electron density decreased rapidly and, as a function of applied power, passed through a sharp minimum. The electron density at the minimum was close (considering the experimental error) to the value at which the plasma frequency becomes equal to the applied frequency. The observed phenomena are ascribed to the effects of resonance between the plasma frequency and the applied frequency, the enhanced excitation of the He 4713 line being ascribed to increase of the energy of the plasma electrons as a result of the resonance effects. The resonance phenomena were not observed at helium pressures below 10-mm Hg because at those pressures the electron density necessary for resonance is reached only at higher powers than were available. (ATD)

18716 ISOLATION AND AMPLIFICATION OF THE DIFFERENCE FREQUENCY IN A PLASMA-BEAM SYSTEM. Kotsarenko, N. Ya.; Fedorchenko, A. M. (Kiev State Univ.). Radiotekh. Elektron., 11: 1325-7(July 1966). (In Russian).

A. M. Fedorchenko examined a method of difference-frequency generation in a plasma-beam system where two electromagnetic waves propagated in the same direction (Radiotekhn. i Elektron., 11: 693(1966)). The present article considers the same system in which the two waves propagate in opposite directions. The second approximation is used in the analysis, which proves that the system can be used for generation of the difference frequency and also for SHF mixers. In principle, a solid-state plasma is also applicable; it would have an advantage of higher attainable frequency and a disadvantage of short relaxation time (10^{-10} to 10^{-12} sec). (ATD)

18717 RADIATION FROM AN ISOTHERMAL HYDROGEN PLASMA AT TEMPERATURES UP TO 40,000°K. Lasher, L. E.; Wilson, K. H.; Greif, R. (Lockheed Palo Alto Research Lab., Calif.). J. Quant. Spectros. Radiative Transfer, 7: 305-22(Mar.-Apr. 1967).

The energy radiated from an isothermal hydrogen plasma was calculated considering both line and continuum emission processes. The principal line broadening mechanism for the plasma conditions considered was electrons interacting with the radiating system. Detailed line profiles were used for the lower members of the Lyman and Balmer series. The higher members were treated as having dispersion profiles. The continuum radiation was calculated using the well known expressions for the continuum absorption coefficients. Results were obtained for temperatures between 10^4 and 4×10^4°K, pressures between 10^{-1} and 10^1 atm, and plasma thicknesses between 10^{-1} and 10^1 cm. (auth)

18718 REFRACTION AND FOCUSING OF SPHERICAL ELECTROMAGNETIC WAVE INCIDENT TO A WEAKLY NONUNIFORM PARABOLIC PLASMA LAYER. Orlov, Yu. I. (Moscow Inst. of Power Engineering). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 30-9(1967). (In Russian).

The method of beam optics is applied to the problem of the spherical electromagnetic wave incidence upon a parabolic plasma layer. The features of the ray ensemble, the field, and the refractive structure owing to the curvature of the incident wave front are analyzed. The special points of the refraction are determined and investigated. The plane of the characteristic parameters of the system is divided into the regions corresponding to the different types of refraction. The evolution is considered, of the ray picture and of refraction connected with the change of the source position, as well as the position and the maximum magnitude of the electronic density. (auth)

18719 KINETIC EQUATIONS FOR RADIATION PROCESSES IN MAGNETIZED PLASMA. Tskhakaya, D. D. (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Izv. Vyssh. Ucheb. Zaved. Radiofiz., 10: 18-29(1967). (In Russian).

Kinetic equations are derived for electrons and photons in a uniform plasma subjected to a strong magnetic field. The radiation collisions are assumed to be the principal interaction mechanism. (auth)

18720 THEORY OF SYNCHROTRON RADIATION IN MAGNETOACTIVE PLASMA. Kaplan, S. A.; Trakhtengerts, V. Yu. (Gorkii State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz., 10: 14-18(1967). (In Russian).

An expression is obtained for the intensity of the synchrotron radiation of a relativistic electron moving at an arbitrary angle in an anisotropic medium. The case when $n_j\beta < 1$ is considered in detail and the case when $n_j\beta > 1$ (n_j is the refractive index, $v = \beta c$ is the total electron velocity) is discussed. For the synchrotron radiation in a magnetoactive plasma the anisotropy influence is essential only in the close vicinity of the plasma frequency. (auth)

18721 SCATTERING AND TRANSFORMATION OF WAVES IN A MAGNETOACTIVE PLASMA. Sitenko, A. G.; Kirochkin, Yu. A. (Inst. of Physics, Kiev). Usp. Fiz. Nauk, 89: 227-58 (June 1966). (In Russian).

A theoretical investigation was made of the electrodynamic properties of a homogeneous magnetoactive plasma. The propagation of waves and excitation of waves by external currents in such a plasma are analyzed on the basis of kinetic theory. The fluctuations of different physical quantities characterizing the state of the magnetoactive plasma are investigated, as are processes of the scattering of waves and their mutual transformation by fluctuations in the plasma. The section headings are: (1) Electrodynamic properties of a magnetoactive plasma (the dielectric tensor and its connection with the particle distribution, the dispersion equation, wave polarization, and energy flux density). (2) Waves in a magnetoactive plasma (high-frequency and low-frequency waves). (3) Excitation of waves in a magnetoactive plasma by external current. (4) Fluctuations in a magnetoactive plasma (collective coherent fluctuations and their correlation functions, effective temperature, fluctuation in equilibrium and nonequilibrium plasmas). (5) Scattering and transformation of electromagnetic waves in a magnetoactive plasma (excitation of high-frequency waves, scattering and transformation of electromagnetic waves by incoherent fluctuations, scattering and transformation by coherent fluctuations, scattering and transformation by Langmuir fluctuations, and scattering and transformation by low-frequency fluctuations). (6) Scattering and transformation of Langmuir waves in a magnetoactive plasma (by incoherent and coherent fluctuations). (7) Transformation of low frequency waves by Langmuir fluctuations in the magnetoactive plasma. (ATD)

18722 QUASI-UNIDIMENSIONAL FLOW IN A PLASMA ACCELERATOR WITH PROGRESSIVE WAVES. Peyret, Roger (Univ., Paris). J. Mecan., 5: 471-515(Dec. 1966). (In French).

The flow of a perfect compressible electrically conducting fluid in an accelerator with progressive waves was studied. The general bidimensional equations controlling such a flow are first given; then the equations of the unidimensional approximation are resolved by the classical method of small perturbations. The solution obtained can not represent the flow at a great distance from the accelerator inlet, and another asymptotic method, the method of multiple coordinates, is then used. The flow caused by the field created by a current ring is calculated to illustrate the extremity effects phenomena. (tr-auth)

18723 THEORY OF CONDUCTIVITY OF ELECTROLYTES AND WEAKLY-IONIZED PLASMA. I. Kremp, D. (Univ., Rostock, Ger.). Ann. Phys. (7), 18: 237-45(Nov. 1966). (In German).

The pair distribution and conductance of electrolyte solutions and weakly ionized plasmas were calculated on the basic of equations given in an earlier paper. The conductance was calculated up to terms of the order $\varkappa^2 a^2 b^2$ and $\varkappa^2 a^2 b^2 \ln \varkappa a$. (auth)

18724 ELECTRON VELOCITY-DISTRIBUTION FUNCTIONS FOR FORCE-FREE OR PARTIALLY FORCE-FREE MAGNETIC FIELDS. Moratz, E.; Richter, E. W. (Univ., Kiel). Z. Naturforsch., 21a: 1963-6(Nov. 1966). (In German).

Based on the Vlasov equation, a method is derived to deliver velocity distributions in the case of a one-component plasma which produces a force-free, or in part, force-free magnetic field. This formalism is applied to simple fields of the type $\Phi = (H_x(z), H_y(z), 0)$. (auth)

18725 RANKINE–HUGONIOT CALCULATIONS FOR NONEQUILIBRIUM PLASMA. Artmann, J. (Deutsche Versuchsan-

stalt fuer Luft- und Raumfahrt, Stuttgart). Z. Naturforsch., 21a: 1960-3(Nov. 1966). (In German).

In optically thin plasmas produced by strong shock waves the Saha equation is no longer valid to describe the conditions directly behind the shock wave. Photoionization may be neglected in the balance of production and recombination of charged particles. For the case of nonequilibrium, a calculation assuming various ratios of electron-to-ion temperature ($\vartheta = T_e/T$) shows that the shock wave parameters are described sufficiently well by the corona equation. Temperature, density ratio, and electron density are increased with increasing ϑ, whereas the pressure ratio is independent of the kind of equilibrium and ϑ. (auth)

18726 INFLUENCE OF A MAGNETIC FIELD ON THE DRIFT VELOCITY OF ELECTRONS CAUSED BY AN ELECTRIC FIELD IN DENSE PLASMA. Daellenbach, W. (Battelle Memorial Inst., Geneva). Ann. Phys. (7), 18: 253-7(Nov. 1966). (In German).

In a dense plasma, under the influence of an electric field E and the collisions with the neutral and positively charged particles, supposed to be at rest on the average, the electron gas reaches a drift velocity u, parallel to E, which is, in general, an empirical function of E. If this function is known, the drift velocity u reached by the electron gas in an electric field E and in presence of a magnetic field B can be deduced by the principle of relativity. (auth)

18727 DERIVATION AND STUDY OF A KINETIC EQUATION FOR LOW-DENSITY HOMOGENEOUS SYSTEM WITH COLLECTIVE MUTUAL EXCHANGE. I. Bessenrodt, R. (Technische Hochschule, Hanover). Ann. Phys. (7), 18: 219-30(Nov. 1966). (In German).

For a nonrelativistic, classical, homogeneous plasma of low density near thermodynamic equilibrium, a simple kinetic equation is derived by starting from Liouville's equation, but without using the conventional Fourier transformations in space. The conservation laws and the H theorem are shown to be valid. (auth)

18728 THEORY OF CONDUCTANCE OF ELECTROLYTES AND WEAKLY-IONIZED PLASMA. II. Kremp, D.; Kraeft, W.-D.; Ebeling, W. (Univ., Rostock, Ger.). Ann. Phys. (7), 18: 246-52(Nov. 1966). (In German).

The starting point is an equation for the pair distribution function given in part I. In part I this equation was solved by a perturbation in terms of the Bjerrum parameter b and the first two approximations were given (containing terms up to b^2). In this paper the distribution function and the conductance of symmetric electrolytes are calculated up to all powers of the Bjerrum parameter. In respect to the concentration n, all the powers higher than n and n log n, respectively, are neglected. Only the terms up to b^2 are screened (Debye screening). In this way long-range divergences in the conductance are avoided. For high b values there is a large decrease of conductance which is due to ionic association. The asymptotic representation of the conductance is given by $\sigma/\sigma_0 = 1 - 4\pi na^3(\exp b)/b$. (auth)

18729 EVALUATION OF THE GYRO-VISCOUS STRESS. Valanejad, Esmail; Greene, John M. (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 41: 492-500(Feb. 17, 1967). (MATT-449).

The second-order stress is calculated for a collisionless plasma in the approximation of small-gyration radius and low-frequency propagation nearly perpendicular to the magnetic field. Unlike previous derivations, higher-order corrections to the distribution function are not required. Instead, higher moments of the Vlasov equation are utilized. This results in a considerable simplification of the derivation. (auth)

18730 CERTAIN NONLINEAR EFFECTS IN COLLISIONLESS PLASMA AND THE POSSIBLE PROSPECTS FOR THEIR UTILIZATION. Danilkin, I. S.; Kovrizhnykh, L. M.; Raizer, M. D.; Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 112-29 (1966). (In Russian).

On the basis of a literature survey it is shown that nonlinear effects arising in collisionless plasma on interaction with an intense high-frequency field can be utilized to expand knowledge in the field of plasma physics, particularly with respect to such aspects of plasma physics as particle acceleration, plasma heating, generation of electromagnetic waves in plasma, and diagnosing the noise arising in plasma. The effects considered include the case of the so-called "weak" nonlinearity when the interaction between electromagnetic waves and the medium (plasma) is small and can be considered from the standpoint of the quasi-linear approach, as well as the case of the conversion of a longitudinal electromagnetic wave to a transverse plasma wave owing to scattering by a charged plasma particle. It is shown that nonlinear effects can determine the steady-state spectra of turbulence (e.g., plasma in an electrical field, ion–sound instability of beams, etc.); have important applications in astrophysics (generation of transverse waves, spectral pumping of longitudinal waves); and are an important factor in the stabilization of universal plasma instability, the structure of shock waves, turbulent diffusion, and spontaneous emission of turbulent plasma. Lastly, these effects cause the processes of the induction of turbulence in plasma by particle beams to be related to intense high-frequency emission. (JPRS)

18731 STATISTICAL ACCELERATION OF PARTICLES IN PLASMA. Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 130-64(1966). (In Russian).

This is a continuation of previous investigations, the difference being that it surveys accomplishments in the theory of the statistical mechanisms of accelerations as based on the development of the theory of weakly turbulent plasma. The subjects discussed include: statistical variation in the state of particles, induced Cherenkov acceleration, acceleration by longitudinal plasma oscillations, nonlinear effects and the limits of applicability of induced acceleration, statistical characteristics of accelerated particles, acceleration of photons and neutrinos, acceleration of plasmons, and acceleration in plasma in external electrical fields as well as in constant magnetic fields. The applicability of the mechanisms of acceleration is illustrated with examples relating to the heating and acceleration of particles in laboratory conditions (x-ray, neutron, electron, and ion acceleration) as well as to astrophysics. In the latter case, it is shown that the acceleration mechanisms associated with the generation of fast particles, particularly cosmic rays, not only are widespread through the universe but also are a factor in evolution and cosmology: they affect the dynamics of the bursts of supernovae, galaxies, radiogalaxies, etc. (JPRS)

18732 PARTICLE ACCELERATION ON INTERACTION BETWEEN HIGH-FREQUENCY FIELDS AND PLASMA. Danilkin, I. S.; Raizer, M. D.; Tsytovich, V. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 165-72(1966). (In Russian).

The conditions are examined under which the mechanisms of particle acceleration may manifest themselves for a plasma exposed to an intense high-frequency field. It is shown that acceleration effects may arise in plasma on excitation with a hf field of longitudinal oscillations, with either random phases ("superthermal" noise of plasma) or a fixed phase. The mechanism of particle injection is essential to these acceleration effects, since particles must be accelerated from energies of the thermal order. Thus, the mean energy of the accelerated ions may reach 0.5 to 1.0 keV and higher. It is further pointed out that both the nonlinear conversion and the instability of plasma in a strong hf field lead to an increase in the absorption of hf power and, thus, may contribute to the transmission of momentum and the acceleration of the plasma blob. The instabilities, developing rapidly in a strong hf field, should lead to an anomalously high turbulent "resistance" of plasma, exceeding the resistance due to collisions. (JPRS)

18733 THEORY OF NONLINEAR WAVE INTERACTIONS IN PLASMA. Kovrizhnykh, L. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 173-205(1966). (In Russian).

Equations which make it possible to describe processes taking place in a plasma, taking account of nonlinear effects, were derived. A long mathematical exposition is followed by calculations of the probability of processes of the second order. The succeeding section treats the probability of dissipation processes. This is followed by the derivation of equations for the interaction of transverse waves in a plasma. The article concludes with a mathematical treatment of several partial cases of the problem. (ATD)

18734 ELECTRON ACCELERATION IN PLASMA PLACED IN A STRONG ELECTRICAL FIELD. Lovetskii, E. E.; Rukhadze, A. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 206-17(1966). (In Russian).

In plasma placed in a strong, homogeneous electrical field the plasma electrons can, in theory, accelerate infinitely. In reality, however, under conditions in which the directional velocity of the electrons exceeds thermal velocity, there arise sufficiently rapidly developing instabilities which cause plasma turbulence and retard electron acceleration. It is shown that even in relatively small electrical fields, E_0, the adiabatic theory of plasma oscillations no longer is applicable, because of the rapid variation in the directional velocity of the electrons. It follows that in a gas betatron filled with a heavy gas, the electrical field $E_0 \sim 10^2$ to 10^3 V/cm can be used to induce an effective acceleration of electrons, with a density $N \approx 10^{10}$ to 10^{11} cm^{-3}, to energies reaching ~10 MeV. The currents will then reach values on the order of several kA. Transverse oscillations in current plasma are excited at electron velocities exceeding the Alfven electron velocity, where the latter should be lower than the velocity of light. The postulates of the nonadiabatic theory of the behavior of plasma in a strong electrical field are more closely defined. A system of relativistic equations of two-fluid magnetic hydrodynamics is employed to describe the behavior of cold plasma in external electrical and magnetic fields. (JPRS)

18735 RADIATION ACCELERATION OF A PLASMA. Veksler, V. I.; Gekker, I. R.; Gol'ts, E. Ya.; Kononov, B. P.; Luk'yanchikov, G. S.; Rabinovich, M. S.; Sarksyan, K. A.; Sergeichev, K. F.; Silin, V. A.; Tsopp, L. E. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 60-79(1966). (In Russian).

A review is given of work done in the field in the Soviet Union, Japan, the United States and France. After a general mathematical introduction to the subject, the first experiments on the radiation acceleration of plasmas using superhigh-frequency generators are described. Detailed diagrams are given of two such systems. Detailed consideration is given to the investigation of the special characteristics of the interaction of superhigh-frequency oscillations in a plasma, including the effect of plasma resonance, and the acceleration of a plasma by the action of the gradient of a superhigh-frequency field. The two final sections deal, respectively, with the acceleration of a plasma in a longitudinal magnetic field and the injection of pure hydrogen plasma clusters of small size. (ATD)

18736 CHARACTERISTICS OF THE MOTION OF A PLASMA CLUSTER IN LONGITUDINAL, TRANSVERSE, AND TWO DIMENSIONAL MULTIPOLAR MAGNETIC FIELDS. Delone, G. A.; Savchenko, M. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 80-8 (1966). (In Russian).

In the experiments, motion of the plasma clusters was created in a glass tube with an inside diameter of 7.7 cm and a length of 100 cm. A spark-type plasma gun was fastened to a flange covering one end of the tube; the other end of the tube was connected to a fitting which had a lateral opening for evacuation. Electric probes were inserted through the end of the fitting. The work was done at a vacuum of (1 to 2) $\times 10^{-6}$ mm Hg. The magnitude of the longitudinal magnetic field was measured from zero to 5000 Oe, and the magnitude of the transverse magnetic field was varied from zero to 1500 Oe. It was observed that the configuration of the plasma cluster depends on the direction of the magnetic moment of the flow "loop" at the gun, with respect to the vector of the transverse magnetic field. The article then passes on to a mathematical consideration of the more complicated case of two dimensional multipolar magnetic fields. It was found experimentally that supply of a negative voltage to the electrode (approximately 500 V) had little effect on the amount of plasma transported. However, if a positive voltage of the same magnitude is supplied to the electrode, the amount of plasma passing through the electrode is decreased by one order of magnitude. (ATD)

18737 INJECTION OF A PLASMA INTO A CLOSED MAGNETIC TRAP WITH A TWO-PHASE HELICAL FIELD. Batanov, G. M.; Grebenshchikov, S. E.; Ivanovskii, M. A.; Sbitnikova, I. S.; Fedyanin, O. I.; Shpigel', I. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 7-19(1966). (In Russian).

A plasma injected into a closed magnetic trap must have the following properties: (1) it must be sufficiently homogeneous in composition (hydrogen or deuterium), it must contain a minimum number of impurities, and the percent ionization must be close to 100; (2) its temperature must be high enough to exclude losses due to normal diffusion in the magnetic field; (3) it must have a high conductivity to eliminate polarization due to the toroidal effect; (4) the plasma, filling the toroidal trap, must not contain marked longitudinal electric fields. The results of an investigation of several methods of injection are presented. The experiments were carried out in laboratory-scale models. The first method tested was injection of the plasma into a "programmed" magnetic field; this method is based on the irreversible change in the configuration of the magnetic field into a determined region of a closed field. The behavior of a plasma was studied under rapid compression by an external azimuthal magnetic field. The method proposed involves injection of the plasma along the tube of the lines of force of a magnetic field extracted from the volume of the trap. Particular attention is paid to the problem of the movement of a sufficiently dense plasma ($n = 10^{12}$ to 10^{13} cm^{-1}) in a curvilinear magnetic channel. A consideration of the collision of plasma flows in the transverse magnetic field of the trap was also made. (ATD)

18738 EXCITATION OF SURFACE CURRENTS ON A PLASMA-IMMERSED CYLINDER BY INCIDENT ELECTROMAGNETIC AND ELECTROKINETIC WAVES. Miller, Edmund Kenneth. Ann Arbor, Mich., Univ. of Michigan, 1965. 303p.

Thesis.

An investigation was made of the surface currents excited by plane electromagnetic, (EM), and electrokinetic, (EK), (or plasma) waves on an infinitely long, perfectly conducting, circular cylinder immersed in a slightly ionized plasma and drawing zero net current from the plasma. The coupling of the EM and EK waves in the inhomogeneous sheath surrounding the cylinder and due to the boundary conditions at the cylinder surface is examined. The primary motivation for this study is to determine the feasibility of detecting the presence of the EK wave in a plasma by a measurement of the surface currents which it might excite on such a cylinder. (TSS)

18739 MEASUREMENT AND INTERPRETATION OF PLASMA PROPERTIES TO 100 KILOBARS OF PRESSURE. Robinson, James William. Ann Arbor, Mich., Univ. of Michigan, 1965. 171p.

Thesis.

Plasmas were produced at near-liquid densities to enable measurements of thermodynamic properties to be made for such conditions. Experimental data were obtained at pressures of 4, 7.7, and 115 kilobars. The pressures were too high for static confinement, so that the plasmas were generated under water which provided transient inertial confinement. Pressure at the higher level was produced by detonating an explosive charge in the vicinity of the plasma. For each level of pressure, the temperature, pressure, and internal energy of the plasma were determined experimentally. Pressure was calculated from measurements of the dynamic conditions in the water surrounding the plasma. Temperature was calculated from a measurement of the blackbody radiation. Internal energy was determined from electrical measurements of the capacitor discharge which formed the plasma. At the lower pressure levels, internal energy was predicted from temperature and pressure data by use of the Debye–Hückel theory of shielding. The predicted values were lower than the measured values by a factor of five, and modifications of the theory offered little chance of significant improvement. The high density of particles created much stronger cohesive forces than the Debye–Hückel theory could successfully describe. The quantum mechanical form of the virial theorem was applied to a model of the plasma which did not distinguish between neutral and ionized atoms. The distortion of electron energy levels introduced the strong cohesive forces which were needed to explain the experimental data. Although the energy per atom was reduced because of the cohesion, the energy per unit volume was increased because of the much higher density. The application of the virial theorem was not quantitatively accurate because of several simplifying assumptions although the physical nature of the cohesive forces was demonstrated. At the higher pressure, the plasma was treated as a partially dissociated gas of water molecules with a very low fraction of ionization. The concept of covolume was introduced to complete the interpretation of the experimental data. In accord with expectations, the covolume was a small fraction of the covolume for water at the critical point. Irregular plasma growth patterns at the higher pressure under certain conditions indicated that ionization was occurring because of the high density. However, the term ionization does not have its usual interpretation at such densities. A large number of electrons were mobile at low temperatures even though Saha's equation predicted a very low level of ionization. (Dissertation Abstr.)

18740 A STUDY OF THE DAMPING OF THE TONKS–DATTNER PLASMA WAVE RESONANCES. Daugherty, Jack Donald. Lafayette, Ind., Purdue Univ., 1966. 239p.

Thesis.

Recent work by Parker, Nickel, and Gould has shown that the experimentally observed secondary Tonks–Dattner resonances may be interpreted as the excitation of plasma waves in an inhomogeneous plasma. However, the theoretical model used by Parker does not explain the strong damping of the resonances as observed experimentally. Principally to identify the effect Landau damping has on these results, this work considers the damping effects of radiation damping, the phenomenological effect of the predominant electron-neutral collisions ($\sim\nu_e$), and Landau damping. To include the latter a macroscopic model incorporating Landau damping is developed and a justification of its application is given. The theory results in a set of eight coupled, first order ordinary differential equations which were integrated numerically to calculate the plasma impedance. To overcome a numerical instability occurring at high plasma densities an asymptotic method was developed to extend the capability of the numerical integration. The calculated wave impedances were compared with the experimental results of Vandenplas and Messiaen. A simple graphical method facilitates comparison of the predictions of the theoretical models. (auth)

18741 KINETIC THEORY OF PLASMAS. Ahearne, John Francis Regis. Princeton, N. J.; Princeton Univ., 1966. 190p.

Thesis.

The hierarchy equations are derived for the time evolution of the one and two-body distribution functions by means of arguments involving only conservation of particles in phase space. Time averages are related to density functions for particles, particle–particle correlations, and particle–field correlations. Correlation functions are introduced via a Mayer expansion and restrictions were made to an infinite homogeneous system, with no external

fields and a fixed positive ion background. An effective potential is defined which has a screening effect. The requirements for truncating the hierarchy equations are discussed. The effective potential is shown to have a range on the order of the Debye length. Lagrangian variables are used to formally integrate the g equation. An iteration procedure for solving for g is then presented by analyzing the phase space. Lagrangian variables based on the effective potential are used to find the lowest order solution for g, $g = f f' - f f'$. This form leads to a Boltzmann equation with a cross section that depends upon the distribution function, and to the H-theorem to lowest order. (TSS)

18742 SCATTERING OF LIGHT FROM ATOMS, MOLECULES, AND FREE ELECTRONS IN GASES AND PLASMAS. Penney, Carl Murray. Ann Arbor, Mich., Univ. of Michigan, 1965. 183p. Thesis.

Some basic relations concerning the scattering of light from particles that are very small compared to wavelengths of interest — specifically free electrons, ions, atoms, and simple molecules — are examined from a consistent application of quantum perturbation theory to a many-body system. Of major concern are particles in gaseous or plasma systems, although many of the results may have broader validity. For the most part attention is confined to nonresonance, linear, single scattering. Higher ordered corrections to the scattering cross section, which arise from the variation of the refractive index from unity, are neglected and the possible effects of variations in the intensity of incident radiation over distances comparable to wavelengths of interest are not considered in detail. The results obtained under these conditions appear to retain wide limits of applicability. However, where necessary, all of these conditions can be relaxed to varying degrees through procedures mentioned. Among the major results obtained are: first, a consistent and informative derivation of the dependence of light scattering in gases on particle–particle interactions; second, a comparatively simple derivation of the angular distribution of the scattered light; third, detailed relations between scattering cross sections and oscillator strengths that permit the calculation of Rayleigh and Raman scattering cross sections under appropriate conditions; and fourth, a relation between familiar quantum expressions for scattering cross sections and refractive indices that is significantly different than the well known classical relation under conditions for which the classical relation is often assumed to be valid. (Dissertation Abstr.)

18743 COLLISIONLESS PLASMA FLOW FIELDS. Kiel, Roger Eugene. Lafayette, Ind., Purdue Univ., 1966. 141p. Thesis.

Flow fields of highly rarefied gases containing charged particles are considered from a kinetic theory viewpoint. The species distribution functions and resulting macroscopic properties are determined in electrostatic flow fields surrounding conducting bodies in rarefied plasmas. The basic approach is an elementary mathematical solution of the governing first order partial differential equation (collisionless Boltzmann Equation) for those symmetric fields in which the Boltzmann Equations for each species and the Poisson Equation may be uncoupled. Under the particular formulation developed, an exact distribution function for particles attracted toward a spherical or cylindrical body in the center of a flow field has been determined which for the first time allows the particles to have a distribution of energies. A limitation on the electrostatic potential field is imposed under this formulation; however, it is found possible to combine results in such a way that almost any potential variation will be acceptable. Using the limited published numerical results available, it was found possible to obtain electrostatic probe currents under this analytic formulation which closely approximated exact numerical results. A formulation considering particles repelled from spherical or cylindrical conductors in a collisionless plasma field obtains exact results with no potential limitations. Calculations for number densities in a field of infinite extent show results to be identical with those which were found from another formulation by two independent investigators as the present work was in progress. However, the results of the present formulation are not limited to fields of infinite domain. A rather complete discussion on electrostatic probes is concerned with the application of the present formulation to problems discussed in earlier works, the first exact solutions for flow fields satisfying the potential limitations imposed for a field of infinite extent, and the proof that the expression for probe "characteristics" given by an earlier publication for moderate probe potentials is in error. The solution for the potential field upstream of a rapidly moving body of low potential is determined, and finally, a formulation along the centerline for the downstream field of such a body is presented. (Dissertation Abstr.)

18744 IMPLOSIVE BEHAVIOR OF MAGNETICALLY-DRIVEN AXISYMMETRIC SLUG-TYPE PLASMA SHEETS. Guman, William John. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 138p. Thesis.

The dynamic behavior of magnetically driven axisymmetric plasma sheets of negligible thickness is examined analytically. A simplified two-dimensional slug model is postulated, and the range of validity of this model is examined by order-of-magnitude considerations. The equations of motion in the axial and radial directions are derived in Lagrangian form for the general case of time-varying current. For the case of constant current, the general solution of the equations of motion is obtained. An evaluation of this solution is found to require the solution of fourth-order ordinary linear differential equations. For the case of a cylindrical implosion driven by a constant current, a simple closed-form solution to the equations of motion has been determined. The dynamic behavior of infinitely long, axisymmetric, slug-type plasma sheets has been examined for cases in which the initial conditions of the plasma sheet are not uniform in space. The initial nonuniformities of the plasma sheet are assumed to be small sinusoidal perturbations of the cylindrical implosion case discussed above. Three types of initial perturbations have been studied, and these include: (1) velocity perturbations, (2) displacement perturbations, and (3) surface mass density perturbations. The solution of these initial-value problems has been carried out by evaluating the general solution of the equations of motion to the first order in ϵ, a small parameter which is defined to be proportional to the maximum amplitude of the initial perturbation. Representative examples have been chosen to illustrate the dynamic behavior of plasma sheets during implosive motion. The plasma sheet configurations, particle trajectories, and the surface mass density variations are presented graphically. In cases for which the wavelength of the initial perturbation exceeds a certain lower limit, the motion of the particles in the plasma sheet is essentially radial. In cases for which the wavelength of the initial perturbation is smaller than in the case just considered, the plasma sheet deforms into a "cusp-shaped" configuration before it reaches the axis of symmetry. The propagation of a slug-type plasma sheet through a curved electrode geometry is also considered. The present formulation postulates that the wall reaction force is negligible at the points where the plasma sheet meets the wall. It is assumed that the plasma does not separate from, or impinge against, the walls of the nozzle, and that the plasma sheet maintains its integrity as it passes through the nozzle. Such assumptions imply that the plasma sheet must be so oriented relative to the wall that the component of the magnetic pressure force that is normal to the wall balances the local centrifugal force. The special electrode nozzle contours that satisfy this compatibility condition are obtained from the solution of an initial-value problem by considering any pair of particle paths as electrode walls. Even though the wall reaction force is negligible in the present formulation, an axial reaction force is exerted continuously on a curved electrode nozzle during the implosion. This axial reaction force exists because of the presence of a magnetic pressure distribution over the interior surface of the curved current-carrying electrodes. (Dissertation Abstr.)

18745 LANDAU DAMPING IN BEAMS AND PLASMAS WITH CYLINDRICAL BOUNDARIES AND MEASURED VELOCITY DISTRIBUTIONS. Gunshor, Robert Lewis. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 232p. Thesis.

The Landau damping theory is extended to the case of finite diameter, cylindrical plasmas, such as would be available in the laboratory. The theory indicates a large increase in collisionless damping over that predicted from the infinite plasma theory. The results of calculations made with this theory are found to compare favorably with recently reported experiments. The finite plasma theory is extended to include moving plasmas in order to investigate space-charge wave damping in electron beams when the velocity distribution may be assumed to be half-Maxwellian. The damping of space-charge waves in a modulated electron beam has been observed. These damped space-charge waves were first reported by Mihran and Caulton. The sensitivity of Landau's theory to the precise shape of the distribution of electron velocities in the beam requires good measurements of the velocity distribution function. Previous attempts to explain the damping in the context of Landau's theory have assumed rather than measured these velocity distribution functions. A new technique has been developed to obtain measurements of the actual velocity distribution in the electron beam. The velocity distribution functions determined from these measurements are used for a direct numerical computer solution of the dispersion relation derived using the finite beam-plasma theory. The results of the solution of the dispersion relation for measured velocity distributions are compared to space-charge waves measured in a density modulated electron beam. Excellent correlation is obtained between theory and experiment for the real part of the electron plasma frequency. The imaginary part of the frequency turns out to be too small to mea-

sure convincingly under the present experimental conditions. The observed damping is mainly in the ballistic phase mixing region where the Landau theory is not applicable. (Dissertation Abstr.)

18746 EFFECTS OF ELECTRON COLLISIONS AND DRIFT VELOCITY ON WAVES IN A PLASMA-LOADED CIRCULAR WAVEGUIDE. Dienst, Joseph Frederick. New Brunswick, N. J., Rutgers-The State Univ., 1966. 170p.

Thesis.

The effects of electron collisions and drift velocity on electromagnetic wave propagation in a plasma-loaded circular waveguide are considered. The field equations and the plasma electron equation of motion, including electron drift velocity and collision terms, are solved and dispersion equations are derived for the plasma completely and partially filling the waveguide. The dispersion equation for the plasma column only partially filling the waveguide is also derived and solved numerically for the TM_{01} mode without approximation. It is demonstrated that for a partially filled waveguide, the only modes which are purely TM or TE are the azimuthally symmetric ones, the others being hybrid modes. In this case the TM_{01} mode dispersion curve exhibits a slow wave branch even in the absence of a drift velocity, in addition to a fast wave branch at higher frequencies. Collisions couple these two branches into a continuous dispersion curve. Experimental measurements of the propagation characteristics of the TM_{01} slow wave mode on cesium and helium plasmas are compared with theoretical curves and show good agreement. An experimentally observed large difference in attenuation constants between waves traveling parallel and antiparallel to the electron drift in a cesium plasma is discussed and cannot be attributed solely to the estimated electron drift velocity in these plasmas. (TSS)

18747 THEORETICAL STUDIES OF PLASMA BOUNDARY SPACE CHARGE SHEATHS. Carlson, Richard William. Minneapolis, Univ. of Minnesota, 1966. 192p.

Thesis.

A theory is developed for calculating the capacitance of the positive space charge sheath that surrounds a probe biased at a highly negative potential with respect to that of the unperturbed plasma. The presence of electrons in the sheath is neglected, and the calculations are applied to the three basic geometries, plane, cylindrical, and spherical. A general model is presented which includes the effects of collisions (e.g., mobility, diffusion, and the volume creation of electron–ion pairs) in the plasma. In particular, calculations are carried out for spherical geometry and an analysis is presented for determining under what conditions ionization in the sheath can be neglected. A more detailed analysis is given for this special case, and sample numerical computations for the solution to Poisson's equation are presented. (TSS)

18748 OSNOVANIYA KINETICHESKOI TEORII; METOD N. N. BOGOLYUBOVA. (Fundamentals of Kinetic Theory; N. N. Bogolyubov's Method). Gurov, K. P. Moscow, Izdatel'stvo Nauka, 1966. 351p.

A general kinetic theory of gas systems (inert gases, electron gases in metals, and plasma) is described and kinetic equations derived by the Bogolyubov method are analyzed and resolved. The Bogolyubov method for classical systems and Kirkwood works are analyzed and a general analysis of the Boltzmann equations and approximation method for estimating particle collision frequencies are included, in addition to the hydrodynamic method for solving kinetic equations. (R.V.J.)

Production of Plasma

18749 (INR-716/XVIII/PP) POMIARY PREDKOSCI FRONTU SWIECENIA W UKLADZIE Z PRETOWYM DZIALEM PLAZMOWYM "DP". (Measurements of Luminous Front Velocity From the Rod Plasma Gun "DP"). Sadowski, Marek; Skladnik-Sadowska, Elzbieta (Institute of Nuclear Research, Warsaw, (Poland)). May 1966. 32p. (In Polish). Dep.

The luminous front velocity of a plasma generated by a new type injector, the rod plasma gun DP, was measured. These measurements were made with a telescope of photomultipliers. Luminous front velocity dependence on initial pressure in an expansion chamber, as well as a dependence on the initial voltage of a condenser bank, were investigated. These results are compared with results of calculations on the basis of a simplified energy balance. Time correlations of integral visible radiation of a plasma with the discharge current and magnetic probe signals were also studied. It was corroborated that azimuthal currents play a substantial part in processes that occur in the plasma generated in the rod gun. (auth)

18750 (N-66-22938) THERMAL ANALYSIS AND STUDY OF ARC-FLOW INTERACTIONS IN THE ANODE REGIME OF AN ELECTRIC ARC. Summary Report. Pfender, E.; Wutzke, S. A.; Shih, K. T.; Eddy, T.; Eckert, E. R. G. (Minnesota Univ., Minneapolis. Heat Transfer Lab.). July 1965. Contract NAS3-2595. 104p. (NASA-CR-54465; HTL-TR-64). CFSTI $3.00 cy, $0.65 mn.

The arc tunnel test facility was supplemented with a plane segmented anode, a plane double anode and several cylindrical anodes. Tests in an argon atmosphere indicated that there is a third mode of operation called the "takeover mode" which is characterized by more or less sinusoidal voltage fluctuations. An attempt was made to explain the significant features of this mode in contrast to the fluctuating mode with a characteristic sawtooth shape of the arc voltage caused by restriking of the arc. The third mode of operation, together with the other two modes described in last year's Summary Report, is found with simplified as well as the more complicated geometries. This finding confirms the assumption that the basic studies of the arc behavior may be performed with simplified arc geometries. A large number of anode energy balances using different anode geometries were established. From spectroscopic measurements, the thermodynamic state of the plasma was determined for one set of arc parameters. Preliminary tests in pure hydrogen atmosphere are also reported. (auth)

18751 (NP-16613) CALCULATION OF THE IONIZATION RATE IN AN ELECTRICAL DISCHARGE IN CESIUM VAPOUR. Rijnhuizen Report 66-36. Postma, A. J. (Stichting voor Fundamenteel Onderzoek der Materie, Jutphaas (Netherlands). Instituut voor Plasma-Fysica). Sept. 1966. 28p. Dep. mn.

Calculations were made of the value of the ionization rate in a cesium discharge, taking into account direct ionization and the process of ionization in steps via the resonance level influenced by capture of resonance radiation. The accuracy of the calculation is limited by lack of knowledge on the excitation cross section of transitions between higher energy levels and the first excited states. A second restriction on the accuracy is the fact that mutual transitions between the higher excited states and recombination have been neglected. The calculated ionization rate is, besides a function of the electron temperature, also a function of the electron density and the gas density, as can be expected from measurements of the electron density and temperature as a function of the pressure in the position column of a Cs discharge. A restriction on the usefulness of the calculated values of the ionization rate is the fact that a Maxwellian velocity distribution function has been assumed. (auth)

18752 (UCRL-50001-66-1, pp 67-70) RADIATION AND PLASMA PHYSICS. (Lawrence Radiation Lab., Univ. of California, Livermore).

Brief summaries of research are presented for the following: improved giant pulses from ruby lasers by changed mirror configuration, plasma temperatures generated by focusing laser giant pulses on surfaces in a vacuum, statistics of laser radiation, kinetic theory for radiating systems, and velocity dependence of the Coulomb logarithm. (M.O.W.)

18753 POSSIBLE OBSERVATIONS OF COLLISIONLESS ELECTROSTATIC SHOCKS IN LASER-PRODUCED PLASMAS. Koopman, D. W.; Tidman, D. A. (Maryland Inst. of Tech., Bethesda). Phys. Rev. Lett., 18: 533-5(Apr. 3, 1967).

In an investigation of laser-produced plasmas, granules of LiD have been irradiated by 15-nsec, 3-J pulses from a ruby laser. The target material consisted of a cluster of solid particles of 5- to 25-μ diam which were injected into the 400-μ-diam laser focal region by an electromechanical apparatus. Expansion velocities of the luminous boundary of the high density plasma were measured from streak photographs with an image converter camera. The preliminary results show that the plasma ball expands into an ambient plasma. (M.O.W.)

18754 SHOCK-INDUCED FLOW INTERACTIONS WITH TRANSVERSE MAGNETIC FIELDS. Johnson, Milton R. (General American Transportation Corp., Niles, Ill.). Phys. Fluids, 10: 539-46(Mar. 1967).

The one-dimensional phenomena which occur when shock-induced flows in ideal gases interact with transverse magnetic fields of finite extent are analyzed from both the steady-state and transient viewpoints. The steady-state analysis assumes steady flow exists within the interaction zone. It is shown that there are four types of interactions. These involve the presence or absence of standing or upstream-propagating reflected shock waves, and rarefaction waves on the downstream side of the interaction zone. The types of interactions are functions of the initial Mach number of the shock-induced flow, the interaction parameter, the magnetic Reynolds number, and the amount of electrical energy withdrawn from the flow. The method of characteristics is used to analyze transient phenomena. The transient problem is described by a five-characteristic network, which is reduced to four characteristic directions when the flow velocity is small compared to the electromagnetic signal velocity. The transient analysis can be used to determine the position where

the reflected shock wave forms and the length of time required for the flow within the interaction zone to approach steady-state conditions. (auth)

18755 INFLUENCE OF A STRONG MAGNETIC FIELD ON OPERATION OF A TITANIUM PLASMA SOURCE. Andryukhina, E. D.; Shpigel', I. S. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1816-18(Oct. 1966). (In Russian).

Ionic current oscillograms were used to study the operating features of a titanium plasma source in the presence of a magnetic field. The magnetic field effects were found to depend on the polarity of the applied voltage. With a negative polarity of the output plate, the total amount of the plasma is reduced. When the polarity is reversed, the velocity of the plasma front and the plasma's density both increase, while the velocity of the front becomes dependent on the applied voltage. Mass-spectrometer measurements have shown that in the presence of a strong magnetic field the energies of H^+ and H_2^+ are higher than if no field is applied. Another effect of the magnetic field is that it eliminates single-charged and heavy ions and reduces admixtures. The effect of the magnetic field is explained by the reduction of the diffusion of the plasma in the instrument's channel and, consequently, the reduction of gas generation on the titanium surface. (ATD)

18756 INVESTIGATION OF A TITANIUM PLASMA SOURCE. I. CONSTRUCTION OF THE SOURCE AND MAIN PARAMETERS OF THE PLASMA. Popov, S. N. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 29-38(1966). (In Russian).

The source is in the form of a row of titanium disks, with a diameter of 14 × 19 mm and a thickness of 2 mm, fed with hydrogen or deuterium. The distance between the disks was 1 mm. The ohmic resistance of the conducting electrodes did not exceed 0.02 to 0.03 ohms, and the conductance of the source under operating conditions, assuming that the plasma pinch completely fills the inner channel of the source, was approximately 30 cm. Using the above equipment, studies were made of several parameters of the plasma generated: density, total number of particles generated, mass and energy spectra, temperature of the electrons and the ions, etc. A figure shows the distribution of the ions with respect to transverse velocities, and a table shows the mean free flight path of ions in the plasma. (ATD)

18757 IONIZATION OF A MEDIUM AND PRODUCTION OF PLASMA BY A LASER BEAM. Askar'yan, G. A.; Rabinovich, M. S. (Lebedev Inst. of Physics, Moscow). Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 89-96(1966). (In Russian).

A review is presented of investigations of the use of laser beams for the solution of numerous problems in plasma physics. The review is considered "preliminary," since it deals with a new field. The first section discusses avalanche ionization of a medium by an intense light flash and is concerned with field strengths of 10^7 V/cm or over. The second section discusses the diamagnetic perturbation due to ionization of the medium in a beam of intense light, specifically, the possible effects on such plasma by external inhomogeneous magnetic fields. The hot plasma's diamagnetism makes it possible for an inhomogeneous magnetic field to act upon it by accelerating the ionized clouds or throwing it into a trap. A very high field strength (10^5 to 10^6 Oe) applied to small plasma clouds can produce extremely high ejection speeds which can be employed for various plasma and prethermonuclear processes. The third and fourth sections concern magnetic traps. The advantages of action of intense light upon dense matter placed directly in a magnetic trap are discussed. The steep characteristic of the dependence of ionization rate of rarefied gas on the intensity of light makes it possible, by increased intensity of the light beam (of about 500 Mw), to ionize fast particles (e.g., 10^8 cm/sec) with a probability close to unity. The most advantageous method would be action upon molecular ion beams directed into the trap. The analysis of the processes involved also shows the advantages of using higher harmonics, polarized atoms, and light beams modulated by half the natural frequency of the atoms in the molecule, and by various resonance manipulations of the pumping field. (ATD)

18758 INVESTIGATION OF A TITANIUM PLASMA SOURCE. II. MASS COMPOSITION, ENERGY SPECTRUM, AND PURIFICATION OF THE PLASMA. Andryukhina, E. D.; Shpigel', I. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 39-45(1966). (In Russian).

This is a continuation of a previous article which demonstrated that, for the titanium plasma source in question, the parameters of a plasma generated by a titanium source (density, total number of particles, distribution of particles with respect to energy) depend essentially on the electrical operating conditions of the source. Data are given on the mass composition of the plasma, the dynamics of the occurrence of impurities, and the structure of the plasma jet. The investigation was done using a mass spectrometer. The plasma source operated under aperiodic or oscillating discharge conditions. In the first case, a damping resistance of corresponding magnitude was introduced into the discharge circuit. The capacitance feeding the source was 1.65 μF. The wave impedance of the discharge circuit was 0.32 ohms, and the period of oscillation under oscillating conditions was 3.2 μsec. Based on the experimental data, a table shows the dependence of the parameters of the plasma on the operating conditions of the source under aperiodic conditions, and a second table gives the same data for oscillating conditions. (ATD)

18759 EXCITATION OF NEUTRAL HELIUM IN NON-LTE DISCHARGES. Johnson, Larry Claud. Princeton, N. J., Princeton Univ., 1966. 80p.

Thesis.

Detailed rate equations for the excitation of neutral helium have been solved, using a variety of assumed cross sections, and the resulting population densities have been compared with measurements on stellarator ohmic heating discharges and afterglows. It is shown that the experimental results can be satisfactorily reproduced by using for excitation cross sections for all allowed transitions a function ln U/U scaled according to the Bethe approximation, where U is the ratio of the incident electron energy to the excitation energy. Other items of interest in the analysis of laboratory and astronomical plasmas are also discussed. (Dissertation Abstr.)

Stability of Plasma

Refer also to abstracts 18622, 18629, and 18706.

18760 (MPI-PAE-PL-1/67) SHEAR STABILIZATION OF DENSITY GRADIENT DRIFT INSTABILITIES. Kitao, Kazuo (Max-Planck-Institut fuer Physik und Astrophysik, Munich (West Germany)). Jan. 1967. 7p. Dep. mn.

The amounts of magnetic shear necessary to stabilize drift instabilities due to density gradient are discussed for a plasma in which β satisfies $m/M < \beta \ll 1$. (M.O.W.)

18761 (ORO-3405-11) INVESTIGATION OF UNIVERSAL PLASMA INSTABILITIES. Annual Progress Report No. 2. Lashinsky, Herbert (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Mar. 1, 1967. Contract AT(40-1)-3405. 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A brief discussion of the thermal plasma device (Q machine) is presented. A brief outline of the research program is also given. (M.O.W.)

18762 (UCRL-70115) ELECTRIC-FIELD EFFECTS IN Q-MACHINES. Hartman, Charles W.; Munger, Richard H. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 3, 1967. Contract W-7405-eng-48. 24p. (CONF-670104-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Conference on Physics of Quiescent Plasmas, Frascati, Italy.

The equilibrium and stability of potassium plasma with internal electric fields perpendicular to the confining magnetic field is studied in a single-ended Q machine. An axisymmetric equilibrium is observed to occur only if the thermoelectric potential distribution in the plasma is symmetrical. This requires symmetry of the hot-plate temperature distribution. When the above conditions are satisfied and the plasma core potential is positive ($\nabla_{\text{hot plate}} > 0$) low frequency ($\omega \approx \omega_{ci}/10$) flute-like waves [$(k_\perp/k_\parallel) \approx 10^2$] are observed which propagate azimuthally at the velocity of the mean ion momentum per unit mass. It is conjectured that the waves are excited by the plasma rotation. When the plasma core potential is negative ($\nabla T_{\text{hot plate}} < 0$), large shear exists in the E/B drifts and similar flute-like waves are observed which are localized in the vicinity of maximum shear. The azimuthal phase velocity is not closely synchronous with drifts of either component. In this case wave excitation is conjectured to arise from velocity shear. (auth)

18763 (NP-tr-1512) LOCAL SHEAR IN A HELICAL MAGNETIC FIELD. Baikov, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Culham Lab., Abingdon, Eng., from a report. 15p. (CTO-339). Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The local shear of the magnetic field lines is determined for an arbitrary magnetic field having magnetic surfaces. The possibility is discussed of using the local shear for the suppression of certain types of drift instabilities in a low pressure plasma. The case of a helical field under conditions in which the distortion of the magnetic field by the plasma currents can be neglected, is discussed in detail. The existence of regions without shear in such a field is demonstrated. (auth)

18764 STABILITY OF A SELF-GRAVITATING PLASMA CYLINDER INCLUDING HALL EFFECT. Hosking, R. J. (Flin-

ders Univ., South Australia). Phys. Fluids, 10: 588-90(Mar. 1967).

A self-gravitating, infinite cylinder of conducting, homogeneous, incompressible fluid in an axial magnetic field is considered with Hall effect included. In the case of axisymmetric modes, an asymptotic analysis for small, nonzero Hall current indicates a destabilizing effect of $O(\epsilon)$, where ϵ is the perturbation parameter. It appears that the increased instability is due to the electron–ion diffusion current, which contributes a radial Lorentz force that is absent in the single-fluid theory. This radial Lorentz force increases the tendency for the cylinder to break up into lengths defined by the perturbation wave number. (auth)

18765 INSTABILITIES DUE TO TEMPERATURE GRADIENTS IN COMPLEX MAGNETIC FIELD CONFIGURATIONS. Coppi, B.; Rosenbluth, M. N.; Sagdeev, R. Z. (International Atomic Energy Agency, Trieste, Italy). Phys. Fluids, 10: 582-7(Mar. 1967).

An integral equation governing an instability due to ion temperature gradients is derived. In the presence of magnetic shear, localized nonconvective normal modes of instability are shown to exist if the relative temperature gradient is larger than that of density, unless the shear is exceedingly strong, i.e., the field shears through a large angle in the distance in which the temperature drops. Quasi modes which are less localized in the direction of the gradient can be constructed from these normal modes and a large thermal diffusion may be expected. Conversely the mass diffusion is shown to be rather slow so that it is reasonable to assume that an effective "divertor" should keep the actual heat loss quite small. (auth)

18766 CYCLOTRON WAVE INSTABILITIES IN A PLASMA. Scharer, J. E.; Trivelpiece, A. W. (Univ. of California, Berkeley). Phys. Fluids, 10: 591-5(Mar. 1967).

Transverse electromagnetic waves that propagate along a uniform magnetic field in an unbounded, thermally anisotropic plasma are investigated. The linearized Vlasov equation is solved to obtain the dispersion relation for the electron- and ion-cyclotron waves. This dispersion relation is used to determine the critical frequencies and wavenumbers below which the wave is unstable. The electron-cyclotron wave is unstable for $T_{e\perp} > T_{ze}$. Numerical solutions for the growth and damping rates of the waves obtained from the dispersion relation show that the maximum growth rate occurs at a frequency slightly below the marginally stable frequency. For the ion-cyclotron wave, both ion and electron thermal anisotropy are included, and cold electrons are shown to have a stabilizing influence on an unstable ion-cyclotron wave; however, when the electrons are thermally anisotropic, they have a destabilizing effect for $T_{e\perp} > T_{ze}$. (auth)

18767 PLASMA ELECTROMAGNETIC INSTABILITIES IN A MAGNETIC MIRROR CONFIGURATION. Scharer, J. E. (Univ. of Wisconsin, Madison). Phys. Fluids, 10: 652-7(Mar. 1967).

An anisotropic Maxwellian velocity distribution with loss cones is used to investigate cyclotron wave instabilities occurring in a magnetic mirror configuration. The density of electrons in the loss cones is assumed to be negligible; this implies that the particle velocity distribution function is such that $f_0(v_\perp, v_z) = 0$ for $|v_z| > v_\perp(R-1)^{\frac{1}{2}}$, where v_z is the component of particle velocity along the magnetic field, $v_\perp$ is the component of particle velocity transverse to the magnetic field, and R is the mirror ratio. Linearized Vlasov equations are solved to obtain the dispersion relation for transverse electromagnetic waves propagating along a uniform magnetic field. Numerical solutions of the growth and damping rates of the wave for a mirror ratio of 2.0 show that there is a long-wavelength instability for a Maxwellian electron distribution with loss cones. The applicability of the analysis to a finite-length mirror configuration is discussed. (auth)

18768 THEORY OF THE INSTABILITY OF CURRENT PLASMA CONFINED BETWEEN CONDUCTING WALLS. Bakanov, S. P.; Lovetskii, E. E. (Moscow Engineering Physics Inst.). Zh. Tech. Fiz., 36: 1955-8(Nov. 1966). (In Russian).

A study is made of the effect of conducting walls on the stability of charge plasma in relation to the buildup of potential fluctuations. High-conductivity metal walls greatly reduce the instability region of charge plasma. This results in a considerable reduction in the accelerating electrical field necessary for "slipping through" the unstable region. A buildup of surface waves is possible on the boundary between the charge plasma and vacuum. It is shown that in the presence of conducting walls this instability can be stabilized, which indicates that conducting walls substantially ease the conditions of unimpeded electron acceleration in a plasma betatron. (ATD)

18769 PLASMA INSTABILITIES AND CONTROLLED THERMONUCLEAR REACTIONS. Kadomtsev, B. B. Vestn. Akad. Nauk SSSR, No. 2, 26-9(Feb. 1967). (In Russian).

The plasma instabilities represent the chief obstacle for achieving controlled thermonuclear reactions. Currently, the main object of study in each of the existing high-temperature devices is some kind of instability. As a rule, the instability may be due to the existence of a nonequilibrium property in the plasma, such as spatial inhomogeneity, nonisothermic character, anisotropy, presence of clusters, etc. The nonequilibrium plasma represents a metastable stage and the oscillations due to instability represent only one of the possible methods for establishing equilibrium within the system. Which type of instability is most critical depends on the actual experimental conditions, i.e., the configuration of the magnetic field, the temperature and the plasma density. For a stable magnetohydrodynamic plasma, slow processes, such as drift, represent the greatest hazard. The calculations carried out indicate that a magnetohydrodynamic plasma can be made stable and a thermonuclear reactor could be built in principle with a magnetic field of about 10^5 oersted and a pinch diameter of about 10 cm. Thus, even though the plasma probably cannot be completely stabilized, the effect of the instabilities may be reduced by increasing the magnetic field. (TTT)

18770 CURRENT-CONVECTIVE (RIPPLING-MODE) INSTABILITY IN A PLASMA IN WHICH THE ION LARMOR RADIUS IS LARGE. Galeev, A. A. Zh. Tekh. Fiz., 36: 1740-3(Oct. 1966). (In Russian).

The effect of the finite ion Larmor radius on the rippling-mode (current-convective) and shear-mode instabilities of an inhomogeneous plasma in a magnetic field is discussed. The calculations are based on the two-fluid magnetohydrodynamic equations including nonquasiclassical terms due to the resistivity and current gradients. The equations obtained for the rippling-mode oscillations reduce in the limit of zero ion Larmor radius to those of H. P. Furth et al. In the case of large ion Larmor radius, the rippling-mode oscillations are fully stabilized. The unstable solutions found by B. Coppi (Phys. Fluids, 7: 1501(1964)) are fictitious because they cannot be spatially localized. When the current gradient is significant there may develop an instability with respect to Alfven-type oscillations. These oscillations are also stabilized in the case of large ion Larmor radius, and in any case they can develop only when the perturbation extends over a considerable region of space. (ATD)

18771 ANOMALOUS DECAY OF THE PLASMA OF AN OSCILLATING ELECTRON (PIG REFLEX) DISCHARGE IN A STRONG MAGNETIC FIELD. Grigorenko, V. G.; Dushin, L. A.; Pavlichenko, O. S.; Skibenko, A. I. Zh. Tekh. Fiz., 36: 1800-7 (Oct. 1966). (In Russian).

An investigation was made of the decay of the plasmas from pulsed PIG reflex discharges in hydrogen at from 0.001- to 0.1-mm Hg in magnetic fields up to 7 kOe. The 6-cm-diameter aluminum cathodes were mounted 108 cm apart and 13 cm from ring anodes in a 10-cm-diameter glass discharge tube. The plasma was excited by the up-to-4-kV discharge of a 200-μF capacitor, the duration of the current pulse being 150 μsec. The plasmas were investigated with an 8-mm-wavelength microwave interferometer; the rate of decay was obtained as a function of the magnetic field strength, the discharging voltage, and the hydrogen pressure. The radial distribution of the plasma density was also measured. Results are presented graphically and are discussed. At magnetic field strengths below 1 kOe, the plasma decayed in accordance with the usual diffusion theory. The rate of plasma decay was minimum at a critical magnetic field strength (above 1 kOe) which was independent of the plasma density but decreased with increasing gas pressure. The signal of the microwave interferometer was found to be modulated at a frequency which decreased with time from about 2 to 0.4 MHz. It is concluded that the anomalously rapid decay of the plasma is due to large-scale drift instabilities that develop during the current pulse. (ATD)

18772 ADIABATIC INVARIANTS AND THE EQUILIBRIUM OF MAGNETICALLY TRAPPED PARTICLES. Hastie, R. J.; Taylor, J. B.; Haas, F. A. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Ann. Phys. (N. Y.), 41: 302-38 (Feb. 2, 1967).

Two topics are dealt with, firstly the conditions for plasma equilibrium in an arbitrary magnetic field and their relation to the lowest order particle adiabatic invariants, and secondly the form of the higher order contributions to these adiabatic invariants. In Part I the equilibrium conditions are investigated in a systematic way: As the time scale of equilibrium is increased the constraints on the distribution function become more severe until they culminate in the requirement that it be a function of the lowest order adiabatic invariants. In Part II it is shown that this discussion of equilibrium leads to a convenient and novel way of generating the adiabatic invariants, not just to lowest order but including higher-order contributions, for which a recurrence formula is derived. When the first correction to the longitudinal in-

variant $J = \oint v_{||}\, ds$ is computed, some interesting differences are found between the case of particles oscillating between mirrors and that of particles circulating round closed field lines. Part III discusses the effect of electric fields and the extension of the calculations to time-dependent magnetic fields, leading to the third adiabatic invariant (the flux invariant). Part IV deals with the case of toroidal magnetic fields possessing magnetic surfaces and the form of longitudinal invariant appropriate in such a field. In the case of small rotational transform a modified line integral for J leads to a convenient description of particle motions in toroidal systems, including the effects of both rotational transform and guiding center drifts. (auth)

18773 INSTABILITY OF THE RELATIVE MOTION OF SPATIALLY SEPARATED ELECTRON STREAMS IN A MAGNETIC FIELD. Mikhailovskii, A. B.; Pashitskii, E. A. Zh. Tekh. Fiz., 36: 1731-6(Oct. 1966). (In Russian).

Stability is discussed with respect to long wavelength potential oscillations of two plasma sheets of finite thickness which meet in a thin plane transition layer and are located in a homogeneous magnetic field parallel to their plane. The wavelength of the perturbation is assumed to be long compared with the electron Larmor radius and the thickness of the transition layer, and the perturbation frequency is assumed to be low compared with the electron Larmor frequency. The motion of the ions is neglected. The calculations are based on the linearized Vlasov equation for the perturbed electron distribution function. A dispersion equation for the long-wavelength oscillations is obtained with the aid of the boundary conditions for the electric potentials at the outer boundaries of the two plasma sheets (assumed to be conducting planes) and the condition for matching the potentials at the boundary between the plasmas (derived by integrating Poisson's equation across the transition region). The dispersion equation is employed to derive stability conditions and expressions for the logarithmic increment in the case of instability, for cold plasma sheets carrying electron currents in opposite directions parallel to the applied magnetic field and for hot plasma sheets with no currents but different electron temperatures. It is found that the current-carrying plasma sheets are not necessarily stable when the external magnetic field is sufficiently strong, but that an additional condition is required for stability, which is violated in the case of long-wavelength perturbations propagating nearly transversely to the magnetic field. (ATD)

18774 INVESTIGATION OF LABORATORY PLASMA INSTABILITIES IN A DIPOLE MAGNETIC FIELD. Quinn, Robert G.; Fiorito, Ralph B. (Pennsylvania State Univ., University Park). J. Geophys. Res., 72: 1611-30(Mar. 1, 1967).

The properties of a steady-state plasma belt confined in a dipole magnetic field and the properties of instabilities arising from this configuration were measured using electric probes and photographic techniques. The spatial variations of the steady-state plasma density and temperature were determined. It is found that in the steady case the electrons are gyrating, mirroring, and drifting for appreciable lengths of time. The character of the instabilities and the conditions under which they arise were measured. The results can be interpreted in terms of a theory originally proposed in 1965 by Swift as a possible mechanism for energizing electrons in the magnetosphere. On this basis speculation concerning comparisons of laboratory and auroral phenomena are made. An alternative theoretical description of the experimental results that uses the basic postulate of Alfvén's 1954 theory on the origin of planetary systems is also discussed. (auth)

18775 TWO COMPONENT EQUILIBRIUM IN THERMAL PLASMAS. Boegershausen, Wilhelm; Hingsammer, J.; Krempl, H. (Technische Hochschule, Munich). Ber. Bunsenges. Phys. Chem., 71: 64-9(Feb. 1967). (In German).

The composition of a zinc–argon mixed plasma in local thermodynamic equilibrium at temperatures between 4000 and 50,000°K was calculated using an electronic computer for a pressure of one atmosphere and zinc concentrations (mole fraction) from 1 to 10^{-9}. At low temperatures the dilution law for electrolytes was valid; at moderate temperatures a coupled equilibrium between the ionization of argon and that of zinc existed. Above 15,000°K the equilibria became almost completely decoupled, because the electron pressure is independent of the element and therefore also of the chemical composition. Further, the influence of dilution on the thermal-excitation function of the Zn-I-line 4810 Å was calculated. The maximum of this function shifted with increasing dilution first to lower temperatures, then split into two maxima, and below a concentration of 10^{-5} tended to a limiting value, which was higher than the norm temperature in the pure plasma. On the sides of the excitation function the intensity of the line was proportional to the concentration; in the central region deviations occurred in certain concentration ranges. It is concluded that the interelement effect in spectrochemistry can be eliminated by using high working temperatures. (auth)

18776 ON MINIMUM-B STABILIZATION OF ELECTROSTATIC DRIFT INSTABILITIES. Saison, R.; Wimmel, H. K. (Institut fuer Plasmaphysik GmbH, Garching, Ger.). Z. Naturforsch., 21a: 1953-9(Nov. 1966).

A check is made of a stabilization theorem of Rosenbluth and Krall (Phys. Fluids, 8: 1004 (1965)) according to which an inhomogeneous plasma in a minimum-B field ($\beta \ll 1$) should be stable with respect to electrostatic drift instabilities when the particle distribution functions satisfy a condition given by Taylor, i.e., when $f_0 = f(W,\mu)$ and $\partial f_0/\partial W < 0$. Although the dispersion relation of Rosenbluth and Krall is confirmed to first order in the gyroradii and in $\epsilon \equiv d \ln B/dx$ the stabilization theorem is refuted, as also is the validity of the stability criterion used by Rosenbluth and Krall, $\langle j \cdot E \rangle \geq 0$ for all real ω. In the case $w_{pi} \gg |\Omega_i|$ equilibria are given which satisfy the condition of Taylor and are nevertheless unstable. For instability it is necessary to have a non-monotonic $v_\perp$ distribution; the instabilities involved are thus loss-cone unstable drift waves. In the spatially homogeneous limiting case the instability persists as a pure loss cone instability with $\mathrm{Re}[\omega] = 0$. A necessary and sufficient condition for stability is $D(\omega = \infty, k, \ldots) \geq k^2$ for all k, the dispersion relation being written in the form $D(\omega, k, K, \ldots) = k^2 + K^2$. In the case $\omega_{pi} \ll |\Omega_i|$ adherence to the condition given by Taylor guarantees stability. (auth)

18777 MOTION OF PARTICLES AND PLASMA EQUILIBRIA IN A STELLARATOR-TYPE MAGNETIC FIELD. Popryadukhin, A. P. Tr. Fiz. Inst., Akad. Nauk SSSR, 32: 46-59(1966). (In Russian).

From the point of view of the possibility of equilibrium in a system, the important question arises as to the existence of magnetic surfaces, when taking into account corrections to the null approximation. The application of magnetohydrodynamics to the question of equilibrium is considered. A mathematical treatment of the problem of a helical magnetic field is given, and then the motion of particles in such a field is considered. The question of equilibrium in a helical magnetic field is considered. This is followed by a consideration of perturbation of magnetic surfaces and determination of the conditions for the existence of closed surfaces. The effect of toroidal characteristics on the magnetic surfaces of a helical field was next considered. It is concluded that the magnetohydrodynamic description of a plasma without collisions in a strong stellarator-type magnetic field is valid only for the partial case of isotropic injection in a minimum magnetic field on a magnetic surface. (ATD)

Thermonuclear Processes

18778 (CONF-661115–1) MUON CATALYSIS OF FUSION REACTIONS. Dean, Stephen O. (Division of Research (AEC), Washington, D. C.). Nov. 2, 1966. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 8th Annual Meeting, American Physical Society, Division of Plasma Physics, Boston, Mass.

Calculations of Jackson on possibility of achieving chain fusion reactions using muons in liquid DT resulted in widespread belief that a muon might catalyze 100 reactions during its lifetime, that capture of muon by helium reaction product prevents continuance of chain, and that process fails by factor five to yield energy balance. These calculations were based on theoretical capture rates. Fusion energy released was compared to energy supplied to protons. Fifty percent conversion efficiency of protons to negative muons was assumed. These questions are here reconsidered based on experimentally measured capture rates. It is shown that an average muon catalyzes only one reaction during its lifetime and hence that capture into helium orbits is not the limiting factor in chain. Accounting for pion production cross section, the process fails by factor 10^8 to achieve energy balance in Jackson's sense. More meaningful balance between fusion energy released and 140 MeV conversion energy for muon creation shows process is inherently incapable of yielding net energy release. (auth)

Shielding

Refer also to abstract 19160.

18779 (DASA–1875) THE WATER CONTENT OF HARDENED CONCRETE. Final Report. Nuclear Radiation Shielding Studies Report No. 4. Hilsdorf, H. (Illinois Univ., Urbana). Feb. 1967. Contract DA-49-146-XZ-319. 108p. CFSTI $3.00 cy, $0.65 mn.

Various parameters affecting the water content of concrete are discussed, and relationships are deduced which allow a conserva-

tive estimate of the water content of various types of concrete. The water content of fresh concrete is controlled primarily by the required workability of the concrete mix. When concrete hardens, the water is either chemically bound to the cement, adsorbed in the pores within the cement gel or present as free water in larger capillary cavities. Additional water may be held within the aggregates. When a concrete member is subjected to drying it loses water and approaches an equilibrium water content which depends mainly on the relative humidity and temperature of the surrounding air as well as on the amount of cement and the pore structure within the concrete. The drying of concrete follows a very slow diffusion process, and under normal temperatures the inner portions of thick concrete sections have a water content considerably above the equilibrium water content even after many years of drying. A procedure is described to estimate the water content of a concrete member: if the initial mix proportions and the exposure conditions of the concrete are known; and if the previous history of the concrete is unknown. Numerical calculations are given to demonstrate the application of this procedure. Finally, values of the water content of concrete are tabulated depending on climatic conditions and age as well as type and size of the concrete member. (P.C.H.)

18780 (KAPL-M-6571) IMPS: AN INFINITE MEDIUM PHOTON SPECTRUM CODE. Dudley, T. E.; Mendelson, M. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 1, 1966. Contract W-31-109-eng-52. 37p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The program IMPS is an infinite medium spectrum code for gamma rays written in FORTRAN II for the Philco 2000. Edits of few-group constants, including the Legendre moments of the group-to-group scattering cross sections, are available for use in transport codes. These moments are based on the Klein-Nishina formula for unpolarized photons. Cross sections are calculated from the bivariate expansions of Capo. The running time per case is short, although somewhat longer than comparable neutron slowing down codes. However, this is not serious for design work as gamma heating calculations and shielding studies do not involve the vast number of "computer runs" which the neutron problems do. The running time of IMPS does increase rapidly, however, with the number of Legendre moments requested. (auth)

18781 (ORNL-3967(Vol.1)) DIFFERENTIAL NEUTRON CURRENT ALBEDOS FOR CONCRETE IN THE INCIDENT ENERGY RANGE 0.5 eV TO 200 keV. I. DESCRIPTIONS OF MONTE CARLO CALCULATION AND TSF EXPERIMENT AND COMPARISON OF CALCULATED AND EXPERIMENTAL RESULTS. Coleman, W. A.; Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Mar. 1967. Contract W-7405-eng-26. 74p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Extensive Monte Carlo calculations were performed to determine the distribution in energy and angle of neutrons reflected from steel-reinforced concrete for five incident directions and ten incident energy groups extending from 0.5 eV to 200 keV. The reflected distributions were determined in terms of a doubly differential albedo for each of 54 emergent directions for each energy group lying between and including the incident group and the tenth group (0.5 to 1.8 eV). The standard deviation of the doubly differential albedo averaged around 10%. The angular slowing-down density of the incident epicadmium neutrons within the slab was computed at 0.5 eV and used as the source distribution for a Monte Carlo single-velocity diffusion calculation using 0.025-eV cross sections. From the diffusion calculation, the differential angular albedos of the reflected subcadmium neutrons and the depth distributions of captures occurring at subcadmium energies were obtained. Measurements of the differential angular albedo of emergent subcadmium neutrons due to a measured spectrum of incident monodirectional beams of epicadmium neutrons were performed at the ORNL Tower Shielding Facility in an experiment geometrically identical to that previously reported for incident subcadmium beams. Of the 35 common points of calculation and measurement, the two largest discrepancies were 23% and 36%; the remaining 33 comparisons produced a root mean square deviation of 4.5%. Tabular results are presented in ORNL-3967(Vols. 2-6) for the calculations for angles of incidence of 0, 45, 60, 75, and 85°; see the following five abstract numbers. (auth)

18782 (ORNL-3967(Vol.2)) DIFFERENTIAL NEUTRON CURRENT ALBEDOS FOR CONCRETE IN THE INCIDENT ENERGY RANGE 0.5 eV TO 200 keV. II. RESULTS OF MONTE CARLO CALCULATIONS FOR AN INCIDENT ANGLE OF 0 deg. Coleman, W. A.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 222p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

18783 (ORNL-3967(Vol.3)) DIFFERENTIAL NEUTRON CURRENT ALBEDOS FOR CONCRETE IN THE INCIDENT ENERGY RANGE 0.5 eV TO 200 keV. III. RESULTS OF MONTE CARLO CALCULATIONS FOR AN INCIDENT ANGLE OF 45 deg. Coleman, W. A.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 222p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

18784 (ORNL-3967(Vol.4)) DIFFERENTIAL NEUTRON CURRENT ALBEDOS FOR CONCRETE IN THE INCIDENT ENERGY RANGE 0.5 eV TO 200 keV. IV. RESULTS OF MONTE CARLO CALCULATIONS FOR AN INCIDENT ANGLE OF 60 deg. Coleman, W. A.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 222p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

18785 (ORNL-3967(Vol.5)) DIFFERENTIAL NEUTRON CURRENT ALBEDOS FOR CONCRETE IN THE INCIDENT ENERGY RANGE 0.5 eV TO 200 keV. V. RESULTS OF MONTE CARLO CALCULATIONS FOR AN INCIDENT ANGLE OF 75 deg. Coleman, W. A.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 222p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

18786 (ORNL-3967(Vol.6)) DIFFERENTIAL NEUTRON CURRENT ALBEDOS FOR CONCRETE IN THE INCIDENT ENERGY RANGE 0.5 eV TO 200 keV. VI. RESULTS OF MONTE CARLO CALCULATIONS FOR AN INCIDENT ANGLE OF 85 deg. Coleman, W. A.; Maerker, R. E. (Oak Ridge National Lab., Tenn.). Nov. 1966. Contract W-7405-eng-26. 222p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

18787 (RISO-136) NUCLEAR PARTICLE TRANSPORT WITH EMPHASIS ON MONTE-CARLO AND SHIELDING CALCULATIONS. Kirkegaard, Peter (Danish Atomic Energy Commission, Risoe, Research Establishment). June 1966. 111p. Dep. mn.

A description is given of a number of methods of calculating the transport of neutrons and γ-rays, mainly in reactor shields. Emphasis has been laid on the Monte-Carlo technique. All the methods described have been programmed for the electronic computer GIER at Risö, and some of them also for the IBM 7090 computer at the Danish Technical University, Lyngby. A simple bulk shield program system has been developed which calculates the penetration of neutrons as well as γ-rays throughout a reactor shield. The neutrons are treated according to the removal-diffusion theory with one removal and one diffusion group. The γ-ray calculation relies on the buildup concept. An improved removal-diffusion neutron shielding program has been worked out, permitting an arbitrary number of removal and diffusion groups. A cross-section library with the elements most frequently encountered in shielding has been prepared. A general outline of the Monte-Carlo calculation method for problems in nuclear particle transport is given. Some minor reactor problems concerning self-absorption of γ-rays in fuel rods and distribution of the energy deposition on the various components of a fuel lattice cell are solved by the Monte-Carlo method. A Monte-Carlo γ-ray shielding program has been written, especially suited for laminated shields, in which case it is superior to buildup methods. The program calculates the energy deposition rate throughout the shield as well as the dose rate at the external surface. Finally, a Monte-Carlo method for computing the axial neutron flux distribution in a short, absorbing rod is presented. Whenever possible, the calculations described in this report have been supported by experimental results. (auth)

18788 (USNRDL-TR-67-9) MOMENTS METHOD COMPUTER CODE FOR RECONSTRUCTING SCATTERED GAMMA RAY DISTRIBUTIONS. Smith, C. V. (Naval Radiological Defense Lab., San Francisco, Calif.). Jan. 17, 1967. 60p.

Two computer programs are presented which together are used to reconstruct scattered angular–energy distributions of monoenergetic photons from their moments. The source configuration for the reconstruction is plane monodirectional. The first program, called MOMGEN, calculates first- and second-order scattering moments, adds them together, and subtracts their sum from a set of total scattering moments. The results are moments for third and higher scattering. The second program, called MOMDIS, constructs third- and higher-order scattering distributions with the moments calculated in MOMGEN. Distributions for first- and second-order scattering, which do not require moments for their formation, are analytically calculated in MOMDIS. The three distributions are added together to give the distribution for total scattering. These programs are written in FORTRAN II for an IBM 704 computer with a 32 K memory. (auth)

18789 (ORNL-tr-1514) A METHOD FOR THE MEASUREMENT OF BUILD-UP FACTORS IN THE GAMMA ENERGY REGION OF 0.5-15 MeV. Futtermenger, W. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1006. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $2.60 fs, $0.95 mf.

A measuring principle is presented which permits a determination of the buildup factors for γ rays in the energy region of 0.5 to 15 MeV as necessary for shield calculations. At the present, a few calculated dose buildup factors and energy absorption buildup factors are available. They exist only for a few elements and can not be simply applied to composite shields. The treatment of γ radiation from the capture of thermal neutrons, which is transmitted obliquely through the layers of the shield, is a particular problem. Suitable buildup factors are not known for this case. The arrangement avoids large radiation fields. A narrow collimated beam is transmitted through a shield model. The spectrum of the emitted γ radiation is measured separately in the beam and in the lateral shield of scattered radiation. Buildup factors can be derived from the two components. High sensitivities can be obtained with an electron accelerator as the generator bremsstrahlung as well as with a sodium iodide scintillation crystal as detector and large layer thicknesses can thus be investigated. Finally, the way build-up factors radiation can be obtained by a variation of the maximum energy of the bremsstrahlung utilized is demonstrated. The method was tested with a baryte concrete of such composition that it was possible to compare the buildup factors obtained with the known theoretical buildup factors. (auth)

18790 (ORNL-tr-1515) INSTRUCTIONS FOR THE USE OF COMPUTER PROGRAMS AVAILABLE AT THE WORKING GROUP OF RADIATION PROTECTION IN CONSTRUCTION. I. SEETZEN PROGRAM AND GRACE I. Sasse, S. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1007. 19p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The classification, program description, formula selection, input, and output for the programs SEETZEN and GRACE I are described. (M.H.R.)

18791 (ORNL-tr-1516) APPROXIMATE CALCULATION OF BUILD-UP FACTORS OF GAMMA-RADIATION IN ORDINARY CONCRETE. Sasse, S.; Wueneke, C. D. (Technische Hochschule, Hanover (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1008. 39p. DTIE.

In the calculation of the attenuation of γ rays, it is customary to use a dose buildup factor B. When the treatment is limited to γ radiation with a source energy E in the range 1 to 8 MeV, and for materials from the group of any ordinary concretes, the buildup factors can be represented as a function of the total γ-absorption coefficient $\mu(E)[cm^{-1}]$ of the particular concrete. The appropriate approximation is developed for the isotropic point source. The two basic types of buildup factors are briefly described in order to establish the concepts and notations. The buildup factors are represented in graphs to permit a simple comparison with known data. (M.H.R.)

18792 IMPORTANCE OF EPITHERMAL NEUTRONS RELATIVE TO THERMAL NEUTRONS IN ABSORBED DOSES. Clark, F. H. (Oak Ridge National Lab., Tenn.). Health Phys., 13: 296-7(Mar. 1967). (ORNL-P-2571).

When, for dosimetric purposes, the neutron field about some relatively high-energy neutron source, say a reactor, is monitored, it is customary to measure at least the fast neutron dose rate and the thermal neutron flux density. There has been a growing practice of measuring also the epithermal neutron flux density or the dose rate attributable to neutrons in the epithermal energy region. The importance of the epithermal neutrons as contributors to the total neutron dose is brought out. (UK)

18793 VARIATIONS IN THE DISTRIBUTION OF THE SPECTRUM OF GAMMA RADIATION FROM ^{137}Cs TRAVERSING ZINC–ALUMINIUM ALLOY, INDUCED BY UNIAXIAL COMPRESSION OF THE ABSORBER. Bujok, J. (Main Inst. of Mining, Katowice, Poland). Acta Phys. Pol., 31: 421-3(Feb. 1967).

In connection with the papers (Bujok, J., Sujak, B., Acta Phys. Polon., 27: 671(1965) and Bujok, J., Acta Phys. Polon., 29: 643 (1966)), results of additional research on Zn–Zn–20Al–5 Cu alloy are presented. The distribution of the gamma spectrum traversing a sample submitted to external uniaxial compressing forces of 0 to 96 tons was investigated. Within this range measurements were made at 34 different values of load. (W.D.M.)

18794 LEAD, MODERN SHIELDING MATERIAL. Smith, R. (Lead Development Association, London). Bull. Inform. Ass. Belge Develop. Pac. Energ. At., 11: No. 63, 9-13(Aug. 1966). (In French).

The advantages that lead offers as a shielding material with respect to other protective materials are outlined. The various special types of lead fabricated for shields and the fabrication techniques are described. (J.S.R.)

18795 SENSITIVITY OF MANNED PLANETARY SPACECRAFT DESIGN TO RADIATION UNCERTAINTIES. Savin, Raymond C.; Deerwester, Jerry M.; Mascy, Alfred C. (Ames Research Center, Moffett Field, Calif.). J. Spacecraft Rockets, 4: 249-54(Feb. 1967).

Radiation shielding requirements can significantly affect the design of spacecraft systems associated with manned planetary exploration. Some effects of on-board and space radiation on shielding requirements for a variety of manned planetary missions are examined. The missions considered include stopover missions to Mercury, Venus, Mars, Ceres, and Ganymede. Chemical and nuclear propulsion systems (including high-thrust and electric) are considered. Results are presented for the effect of mission duration on spacecraft shielding requirements; galactic, reactor, and solar radiation are considered. The sensitivity of shield weight to uncertainties in solar flare frequency, allowable dose, and recovery factor is also examined. (auth)

Solid-State Physics

Refer also to abstracts 18335 and 19237.

18796 (COO-525-23) SIMULTANEOUS PRODUCTION AND BLEACHING OF F CENTERS. Covault, Dennis Owen (Nebraska Univ., Lincoln). Dec. 1966. Contract AT(11-1)-525. 82p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

It has been found that simultaneous irradiation with x rays and light in the neighborhood of room temperature causes a super recovery of the F band upon subsequent x irradiation in the dark, in all KCl crystals tried except for the very pure and the very impure. That is, the F-band growth obtained in the above manner surpasses that of a companion crystal x irradiated only in the dark. The portion of the bleaching spectrum responsible is the F band. This super recovery was not found at liquid nitrogen temperature in KCl or in other alkali halides at room temperature. It was found to increase monotonically with the F-band bleaching intensity to a saturation value. It was also found to be a strong function of the irradiation temperature. There is some evidence from optical bleaching that the F centers in the crystals that were simultaneously x irradiated and bleached differ from those in the crystals that were x irradiated only. Attempts to explain these results theoretically have been unsuccessful. (auth)

18797 (COO-525-24) STORED ENERGY IN IRRADIATED SODIUM CHLORIDE. Bunch, James M. (Nebraska Univ., Lincoln). 1967. Contract AT(11-1)-525. 144p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A differential thermal analysis technique has been used to measure the stored energy in x- and γ-irradiated NaCl containing F-center concentrations as high as 1.8×10^{18} cm^{-3}, and relatively small concentrations of M, R, and higher aggregate centers. The total stored energy from x irradiated pure samples was found to vary approximately linearly with the F-center concentration plus twice the M-center concentration, for F-center concentrations between 3×10^{17} and 13×10^{17} cm^{-3}. The energy per F center, assuming that each M center contributes twice as much energy as one F center, was 12.4 ± 0.3 eV. The total energy from samples which were γ irradiated well beyond the saturation of the F-center concentration at 7×10^{17} cm^{-3} was about 20% larger than that from x-irradiated samples with identical F-center concentrations. Also, it was observed that the scatter in the total energy values from the x-irradiated samples increased with sample coloration. These effects are attributed to energy contributed by R and higher aggregate centers. It is suggested that the appearance of these centers was partially suppressed in some of the samples by the presence of impurities. This interpretation is consistent with the observation that the stored energy from the calcium-doped sample, in which the appearance of the R and higher aggregate bands was completely suppressed by the impurities, was near the extrapolation of the energy from less heavily colored samples. (P.C.H.)

18798 (IS-T-122) A STUDY OF THE EFFECTS OF IMPURITIES AND VACANCIES ON NUCLEAR MAGNETIC RESONANCE LINE SHAPES IN INTERMETALLIC COMPOUNDS. Lecander, Ronald Glen (Ames Lab., Iowa). Feb. 1967. Contract W-7405-eng-82. 171p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Nuclear magnetic resonance (NMR) line shapes were analyzed to obtain the local variation of the hyperfine interaction due to impurities or vacancies in intermetallic compounds. The line shape of the Sc^{45} NMR was studied in $Sc(Ni_{1-x}Co_x)_2$ pseudobinary

alloys at room temperature. For low cobalt concentrations, these line shapes were described by an inhomogeneous Knight shift due to the hyperfine interaction with an oscillating charge density surrounding the cobalt atoms. The magnitude and sign of these interactions were accounted for by resonant scattering of conduction electrons by virtual d levels of the cobalt atoms. The NMR of scandium was observed across the entire alloy system. A long range interaction was necessary to describe the average Knight shift variation with composition. This shift was positive for low cobalt concentrations and became negative for very high cobalt concentrations. The latter were related qualitatively to the magnetic susceptibility but the relationship was not linear. The NMR of V^{51} was studied at room temperature in VC_x nonstoichiometric compounds for $0.75 < x < 0.88$. The shape of the resonance in $VC_{0.88}$ and the variation of the average Knight shift as a function of the carbon vacancy concentration was described by a hyperfine interaction due to first nearest neighbor carbon vacancies. An unsuccessful attempt was made to explain this local interaction by assuming the scattering of conduction electrons by the vacancy using a spherical square well potential. A negative Knight shift of −0.187% was obtained for V^{51} in stoichiometric VC, which could not be accounted for on the basis of susceptibility measurements. (auth)

18799 (LA-DC-8593) SOME RECENT AUGMENTED PLANE WAVE CALCULATIONS. Wood, J. H. (Los Alamos Scientific Lab., N. Mex.). [1967]. Contract W-7405-eng-36. 31p. (CONF-670206-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 96th Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Los Angeles, Calif.

The kind of information derivable directly from augmented plane wave band calculations and the reliability of that information are considered. A typical atomic calculation is given briefly, and then the corresponding band calculation is presented. In both calculations the solutions (wave functions and energy eigenvalues) of a one-electron Schroedinger equation are discussed. The element considered in both sets of calculations is Cu. It is concluded that these band calculations can yield good agreement with experiment providing the correct Hamiltonian or potential energy function can be found. (A.G.W.)

18800 (NYO-2047-38) INVESTIGATIONS OF RADIATION EFFECTS IN SOLIDS (METAL OXIDES, ALKALI AZIDES, AND BIFLUORIDES) BY ELECTRON SPIN RESONANCES. Progress Report, February 1, 1966–January 31, 1967. Gilliam, Otis R. (Connecticut Univ., Storrs. Dept. of Physics). Contract AT(30-1)-2047. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Spin-Hamiltonian parameters have been obtained for three paramagnetic defects in electron-irradiated $CaMoO_4$, two of which are also obtainable by gamma irradiation. Four radiation-generated optical absorption bands are observed and studied with relation to the ESR spectra. Calcium molybdate doped with cerium ions has been examined to determine the spin-Hamiltonian parameters of Ce^{3+} ions substitutional for Ca^{2+}, and to examine the influence of charge compensation on the ESR spectra. A paper on F_3^- ions in electron-irradiated KHF_2 has been submitted and accepted for publication during the year. Similar studies are being conducted of irradiated $NaHF_2$ and other bifluorides. Experiments are in progress to determine the influence of sample source on the generation of defects in reactor-irradiated sapphire. (auth)

18801 (NYO-3464-6) F_3^+ CENTER IN NaF. Stiles, Lynn F. Jr. (Cornell Univ., Ithaca, N. Y.). Feb. 1967. Contract AT(30-1)-3464. 69p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Spectral studies were made on F_3^+ centers radioinduced in NaF by x rays at room temperature. The location of the 5456-Å zero-phonon line and its associated band, and the results of uniaxial stress measurements in absorption and emission very strongly support an ionized R-center model for this center. The location of the 0.52-μ absorption band compared favorably with the transition energy calculated for the continuum model for the trigonal F_3^+ center. The energy calculation also indicated that the lowest allowed optical transition is an $A \rightarrow E$ transition. Uniaxial stress splittings in absorption verified this assignment. Also, the stress induced polarization of the line in emission was consistent with that expected for the degenerate excited state. (P.C.H.)

18802 (ORO-2755-17) SURFACE PROPERTIES OF MAGNETIC MATERIALS. Progress Report No. 7, March 1, 1966–February 28, 1967. Scheibner, E. J. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Contract AT(40-1)-2755. 45p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An apparatus for surface studies is described, which combines the advantages of low-energy electron-diffraction patterns and secondary emission measurements. The energy distributions of electrons reflected from the (100) face of copper single crystals were obtained. The effects of surface conditions on the results were determined, and a cleaning procedure was established. The peaks in the energy distribution curves are interpreted as arising from plasma resonances, interband transitions, and Auger processes. Effects of varying amounts of oxygen adsorption on the energy-loss spectrum were observed. Results of measurements of the energy distributions of slow electrons scattered from the basal plane of graphite are also presented. Work in progress on the thermodynamics of surface phase transitions is summarized briefly. The planar anisotropy and rotational hysteresis of thin films of gadolinium were studied using torque measurements. The uniaxial anisotropy constants measured were 10^4 to 10^5 erg/cc. The films showed a unidirectional rotational hysteresis. Peak loss occurred at field strengths between 0.5 and 1 kOe and losses remained significant up to 10 kOe. An appendix contains abstracts of six papers based on this work. (A.G.W.)

18803 COULOMB-RECOIL-IMPLANTATION MOESSBAUER EXPERIMENTS WITH ^{73}Ge. Czjzek, Gordon; Ford, J. L. C. Jr.; Love, John C.; Obenshain, Felix E.; Wegener, Horst H. F. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett., 18: 529-31 (Apr. 3, 1967). (ORNL-P-2920).

Coulomb-excited ^{73}Ge was implanted into metallic Cr, and the Moessbauer effect was observed with the 67-keV de-excitation radiation. A beam of unanalyzed O ions was used, and the Moessbauer effect with a given absorber was measured as a function of the beam current. (D.C.W.)

18804 PROTON KNIGHT SHIFTS IN THE LIGHT RARE EARTH–HYDROGEN SYSTEMS. Kopp, J. P.; Schreiber, D. S. (Northwestern Univ., Evanston, Ill.). Phys. Lett., 24A: 323-4 (Mar. 13, 1967).

Large temperature-dependent Knight shifts are reported for the ^{1}H NMR in the alloys (Ce, Pr, Nd, and Gd)H_x where $2 \leq x < 3$. (auth)

18805 INELASTIC SCATTERING OF NEUTRONS BY SPIN WAVES IN fcc COBALT. Frikkee, E. (Reactor Centrum Nederland, Petten). Physica, 32: 2149-60(Nov.-Dec. 1966).

Inelastic neutron scattering experiments were performed on the ferromagnetic alloy $Co_{0.91}Fe_{0.09}$ by means of the diffraction method. The magnon dispersion relation was found to be of the form $\hbar\omega(q) = \hbar\omega(o) + Dq^2$ for wave vectors $q < 0.11$ Å^{-1}, with $\hbar\omega(o) = 0.52 \pm 0.16$ MeV and $D = 275 \pm 16$ MeV Å^2. For $q \approx 0.11$ Å^{-1}, a deviation from the quadratic form was observed. The possible influence of magnon–phonon interaction and magnon conduction electron interaction on the magnon dispersion relation is discussed. (auth)

18806 RECOIL NUMBERS IN CRYSTALLINE STRUCTURES. Sanders, J. B. (Stichting voor Fundamenteel Onderzoek der Materie, Amsterdam). Physica, 32: 2197-2200(Nov.-Dec. 1966).

The number of recoil atoms in a low energy interval resulting from an energetic projectile entering a crystalline solid is calculated, using Lindhard's power potential approximation for the interatomic interaction. (auth)

18807 DEFECT CLUSTERS IN ELECTRON- AND IN NEUTRON-IRRADIATED LITHIUM FLUORIDE. Mannami, Michihiko; Akisue, Osamu; Tanaka, Kenzo (Kyoto Univ.). Jap. J. Appl. Phys., 6: 283-9(Mar. 1967).

The defect clusters in LiF irradiated by thermal neutrons and by 100-keV electrons have been studied by transmission electron microscopy. The defect clusters in the electron-irradiated crystals are formed after exposure to about 10^{14} electrons/cm^2 and they are some 30 Å in diameter having no crystallographic orientation relation to the matrix. They grow larger under subsequent electron irradiation and stop growing when they are about 500 Å in diameter. The defect clusters in the crystals exposed to $10^{13} \sim 10^{18}$ nvt of neutrons are platelets parallel to one of the {100} planes. They are less than 200 Å in diameter and less than 50 Å in thickness. Their density, about 5×10^{15}/cm^3, is almost independent of exposure. It is probable that the defect clusters in electron- and neutron-irradiated crystals are of same nature, since the defect clusters in neutron-irradiated crystals grow as a result of electron irradiation during observation in the electron microscope. No inhomogeneous line defects have been observed. (auth)

18808 ANNEALING OF IMPURITY RECOMBINATION BANDS IN SILICON IRRADIATED BY γ RAYS. Yukhnevich, A. V.; Tkachev, V. D.; Bortnik, M. V. (Belorussian State Univ., Minsk). Soviet Phys.-Solid State (Engl. Transl.), 8: 2571-4(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3213-17(Nov. 1966).

The isochronal anneal of infrared radiation bands in silicon caused by radiative recombination of excess carriers via radiation defect levels has been investigated. Over the temperature range 25 to 600°C successive appearance and disappearance of various

bands was observed; this indicates the complex character of the rearrangement of defects that occurs during annealing. It is shown that oxygen atoms play an important role in the formation of most of the defects giving rise to recombination radiation. (auth)

18809 PHOTOELECTRET STATES IN SILICON CONTAINING RADIATION DEFECTS. Gerasimov, A. B.; Konovalenko, B. M.; Ryvkin, S. M.; Umarova, Kh. F.; Yaroshetskii, I. D. (Ioffe Inst. of Physics and Tech., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 2581-5(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3226-31(Nov. 1966).

The results of an investigation of the photoelectret state in silicon containing radiation defects are presented. The dependence of polarization on intensity and time of application of the electric field, the retention of polarization as a function of time, and the spectral selectivity of the effect have been studied in samples having different Fermi-level positions. (auth)

18810 EFFECT OF FAST ELECTRON IRRADIATION ON THE PHOTOCONDUCTIVITY SPECTRA OF GaAs CRYSTALS GROWN IN AN OXYGEN ATMOSPHERE. Plotnikov, A. F.; Selezneva, M. A. (Lebedev Inst. of Physics, Moscow). Soviet Phys.-Solid State (Engl. Transl.), 8: 2712-13(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3392-3(Nov. 1966).

The photoconductivity of n-type GaAs crystals grown in an oxygen atmosphere and irradiated by 1-MeV electrons was compared with that of a crystal subjected to the same treatment except that it was not doped with oxygen. A center at $E_c - 0.65$ eV was observed in the crystals grown in the oxygen atmosphere in addition to those observed in the undoped crystals. It is suggested that in GaAs grown in an oxygen atmosphere a large concentration of oxygen can reside in the lattice in an electrically inactive state, and that, when defects are introduced by irradiation, some of the oxygen is transformed from the inactive state to the state associated with a level at $E_c - 0.65$ eV. (A.G.W.)

18811 CATHODOLUMINESCENCE SPECTRA OF SILICON CARBIDE CRYSTALS IRRADIATED BY FAST ELECTRONS. Makarov, V. V.; Petrov, N. N. (Kalinin Polytechnic Inst., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 2714-15(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3393-4(Nov. 1966).

Cathodoluminescence spectra of n-type SiC crystals containing about 10^{17} nitrogen atoms/cm^3 before and after irradiation by 2-MeV electrons are shown. Neither polishing and etching nor heat treatment changed the shape of the spectra. Bombardment of the crystals by ions (Li^+, K^+, N_2^+, He^+, Ar^+) showed that the shape of the spectra does not depend on the nature of the bombarding particle. In samples with a large nitrogen content, the electron- or ion-induced changes in the cathodoluminescence spectra were not so large. The activation energy for the quenching of the green band in the spectra was determined to be 0.09 to 0.11 eV. It is suggested that the luminescence is caused by electronic transitions from the nitrogen level to an acceptor level that appears as a result of irradiation. (A.G.W.)

18812 INTERACTION OF RADIATION DEFECTS WITH DISLOCATIONS IN GERMANIUM. Khainovskaya, V. V.; Smirnov, L. S. (Inst. of Semiconductor Physics, Novosibirsk, USSR). Soviet Phys.-Solid State (Engl. Transl.), 8: 2724-5(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3403-4(Nov. 1966).

Observations of the movement of dislocations during irradiation of Ge with a 3.5-MeV electron beam were used to study the interaction of radiation defects with dislocations. A photograph of the positions of dislocations before and after irradiation shows clearly the displacement of etch pits relative to their initial positions in [111] directions. This is evidence of dislocation climb, possibly by absorption of vacancies or interstitial atoms. The average climb distance was ~20μ. On studying the whole surface of a specimen, individual cases were observed of the annihilation of dislocations, of dislocations remaining fixed, and, rarely, of movement of dislocations in the opposite direction. (A.G.W.)

18813 STRUCTURAL CHANGES IN QUARTZ DURING THE $\alpha \rightarrow \beta$ TRANSFORMATION AND DURING NEUTRON IRRADIATION. Kolontsova, E. V.; Telegina, I. V. (Moscow State Univ.). Soviet Phys.-Solid State (Engl. Transl.), 8: 2733-5(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3412-14(Nov. 1966).

The changes occurring on heating α quartz were compared by diffuse scattering and Laue methods with the structural transformations observed in α quartz during neutron bombardment. It was found that the temperature-controlled transformation $\alpha \rightarrow \beta$ (up to about 700°C) is closely related to the structural changes observed during neutron irradiation of 10^{19} to 5×10^{19} n/cm^2. It is concluded that displacements form the basis of transformations of this type, and the displacements are controlled by the field of interatomic interaction independently of the source of the displacements. (A.G.W.)

18814 INELASTIC SCATTERING OF ELECTRONS IN BERYLLIUM AND LEAD FOR HIGH ANGLES OF INCIDENCE OF THE PRIMARY BEAM. Bronshtein, I. M.; Dolinin, V. A. (Gertsen State Pedagogical Inst., Leningrad). Soviet Phys.-Solid State (Engl. Transl.), 8: 2744-5(May 1967).

Translated from Fiz. Tverd. Tela, 8: 3422-4(Nov. 1966).

The inelastic scattering of electrons in Be and Pb was investigated at angles of incidence of 60 to 89° and at primary electron energies of 0.1 to 5 keV. Inelastic reflection coefficients and the effective depth of emergence of the inelastically reflected electrons were determined as functions of the primary electron energy. Results indicated that for glancing angles of the primary beam close to zero, the scattering powers of all substances were similar. Electrons of all investigated energies apparently moved in Pb in a basically diffuse fashion. In Be the nature of the electron motion depended strongly on the electron energy; the higher the electron energy, the more rectilinear were the electron paths. (A.G.W.)

18815 ATOMIC-SCATTERING FACTOR OF X RAYS AND ELECTRONS IN THE SLATER APPROXIMATION. Buntar', A. G. Soviet Phys.-Cryst. (Engl. Transl.), 11: 619-25(Mar.-Apr. 1967).

Translated from Kristallografiya, 11: 722-30(Sept.-Oct. 1966).

The scattering of x rays and electrons by atoms with spherically asymmetric electron-density distributions is considered. An analytical expression is obtained for the atomic factors, using wave functions in the Slater approximation. It is shown that the nature of the x ray and electron scattering depends considerably on the distributions of the atomic electrons over the quantum states, and also on the recording conditions. (auth)

18816 ELECTROMAGNETIC WAVES IN METALS IN MAGNETIC FIELDS. Kaner, E. A.; Skobov, V. G. (Inst. of Radiophysics and Electronics, Academy of Sciences, Ukrainian SSR. Ioffe Inst. of Physics and Technology, Academy of Sciences, USSR). Usp. Fiz. Nauk, 89: 367-408(July 1966). (In Russian).

It is shown that the hitherto prevailing opinion that no low-frequency electromagnetic waves can propagate in metals is not supported by modern notions of solid-state theory. They consequently review extensively the latest literature on electromagnetic waves, defined as collective oscillations of an electron–hole plasma of a metal, in light of recent theoretical and experimental proof that various electromagnetic waves can exist at low temperatures and in the presence of the magnetic field in metals, and in light of new resonant effects, such as anomalous transparence of metals, resulting from such waves. Tables summarizing the various types of waves, the conditions under which they exist, their spectrum, their relative damping and polarization, are presented for slow and fast helicon waves, magnetohydrodynamic waves, Alfven waves, magnetic-sound waves, low- and high-frequency waves with discrete and continuous spectra, ordinary and extraordinary waves, longitudinal waves, and others. (ATD)

18817 PRESSURE CONSIDERATIONS OF MOESSBAUER EFFECT. Mahesh, Krishan (Kurukshetra Univ., India). Indian J. Pure Appl. Phys., 4: 480-2(1966).

An expression connecting the Mössbauer coefficient (f) with the pressure applied on the lattice has been derived and the effect of pressure on f has been examined from a study of 10 gamma-emitting radioisotopes having a wide-range of compressibilities, using this expression. The variation of f with pressure in the range 0 to 100 kbars is linear except for radioisotopes of relatively large compressibility. The over-all enhancement in f with pressure is seen generally to increase with the compressibility of radioisotope, though no definite regularity can be ascertained. (auth)

18818 SOME INVESTIGATIONS ON THE ELECTRIC AND MAGNETIC PROPERTIES OF Cr_2O_3–BeO SYSTEM. Ursu, I.; Pop, O.; Stanescu, L.; Pop, Iuliu (Univ. of Cluj). Rev. Roum. Phys., 11: 751-8(1966).

Measurements of electric resistivity as a function of temperature carried out on the Cr_2O_3–BeO system at various concentrations of the components indicate a minimum resistivity for 30 mole % BeO, after a very sudden drop at 5 mole %. The examined system is a semiconductor of p-type. The influence of the addition of BeO on the magnetic behavior of the system was examined by ESR and magnetic susceptibility methods. It seems that BeO additions result in substantial increases of magnetic susceptibility up to 50 mole % BeO. From magnetic, dynamic, and static measurements, results indicate that the Cr_2O_3–BeO system is antiferromagnetic throughout the concentration domain examined. (auth)

18819 A CHEMICAL METHOD FOR DETERMINATION OF F-CENTERS IN ^{60}Co γ-IRRADIATED SODIUM CHLORIDE. Rabe, J. G. (Hahn-Meitner-Institut fuer Kernforschung, Berlin). Ber. Bunsenges, Phys. Chem., 71: 108-12(Feb. 1967). (In German).

When ^{60}Co-γ-irradiated crystals of sodium chloride were dissolved in an acid aqueous solution containing alcohol, hydrogen gas was formed. For natural crystals and melt-grown crystals, which were free of hydroxide ions to a high grade, the hydrogen yield was proportional to the absorption coefficient measured at the F-band maximum. The chemical determination of F centers completed optical-absorption measurements. F centers were chemically determined in polycrystalline salts and in high concentrations. Annealing of F centers by light, which led to M centers, did not markedly change the H_2 yield. The oscillator strength of the F center was equal to 0.75. (auth)

18820 APPLICATIONS OF NEUTRON DIFFRACTION AND SOME NEW RESULTS. Kleinstueck, K. Wiss. Z. Humboldt-Univ. Berlin, Ges. Sprachwiss, Reihe, Beil. I, 13: 53-8(1964). (In German).

The fundamental quantities for the determination of neutron diffraction diagrams and the chief areas where the method is being used are discussed. Several examples are given in which some more recent developments are outlined, particularly applied studies. The possibilities of the method for acquiring information are explained. The various types of scattering (nuclear scattering and magnetic scattering) of neutrons are examined. The properties of the scattering amplitudes of atomic nuclei are collected in a table, and their properties are contrasted with the x-ray scattering amplitudes of these elements. A discussion of the scattering amplitude and its division into coherent and incoherent parts is given. The coherent magnetic scattering amplitude is also discussed. (BBB)

18821 ON THE PHOTOSTIMULATED EMISSION OF EXO-ELECTRONS FROM PLASTICALLY DEFORMED NaCl MONO-CRYSTALS CONTAINING F CENTRES. Pirog, M. (Higher Pedagogical Coll., Opole, Poland); Kowalczyk, R.; Sujak, B. Acta Phys. Pol., 31: 277-83(Feb. 1967).

Samples cut from NaCl monocrystals were investigated after previous removal of stress by thermal treatment (tempering). The tempered samples were colored by irradiation with x rays. It was found that the emission of exoelectrons occurs only in the plastic deformation region. Preliminary results indicate that there is a dependence between the kinetics of forces acting on the investigated specimen. (auth)

18822 EXCITATION OF LUMINESCENCE FROM KI:Tl AT 5°K. Kaufman, R. Gilbert; Hadley, Wayne B. (Zenith Radio Corp., Chicago). J. Chem. Phys., 46: 1598-1601(Mar. 1, 1967).

Emission and excitation spectra of single and double thallous ion fluorescence are measured in KI:Tl (0.06 mole %) at 5°K. Spectra are also measured of the emission during x irradiation, of the emission stimulated after irradiation. There are differences between the stimulated emission, which is entirely the result of recombination of electrons and holes, and the x-ray induced emission. Two possible interpretations of the differences are discussed and the suggestion is favored that hot electrons produced in the radiation shower excite optically available states of the thallium ion. (auth)

18823 SECOND-ORDER NUCLEAR DIPOLAR CONTRIBUTION TO SECOND MOMENT OF INTEGER SPINS. Choy, W. T. P. (Univ. of Florida, Gainesville). J. Chem. Phys., 46: 1578-9 (Mar. 1, 1967).

A formula has been derived for the second-order contribution of the dipolar broadening to the second moment of the resonance lines in pure quadrupole resonance experiments. The following assumptions have been made: The nuclei undergoing the resonant transitions have spin $\frac{1}{2}$; all resonant spins experience the same electric-field gradient, which has a small amount of axial asymmetry; the dipolar interaction strength is small compared with the separation of the two resonance lines. (auth)

18824 A STUDY OF STRESS WAVES PRODUCED BY PULSED HIGH-ENERGY RADIATION. Peffley, W. M. (Hughes Aircraft Co., Fullerton, Calif.). Appl. Phys. Lett., 10: 171-3(Mar. 15, 1967).

Transient pulses of 10-MeV electrons from a linear accelerator were employed to generate stress waves in cylindrical rods of various materials. A piezoelectric accelerometer was used to determine the velocity of the induced stress wave and monitor the acceleration experienced by the end of the bar. A solution of the one-dimensional wave equation, as altered by a specific thermoelastic term which acts as a forcing function exciting a finite bar, was obtained. The resulting qualitative agreement with the experimental findings is discussed. (auth)

18825 DYNAMICS OF A CRYSTAL LATTICE WITH DEFECTS. Lifshitz, I. M.; Kosevich, A. M. (Inst. of Physics and Tech., Kharkov). Rep. Progr. Phys., 29: 217-54(1966).

The dynamic phenomena connected with isolated defects in a lattice and the dynamics of a crystal with various types of defects are examined. Simplified models are used in the interpretation of the results and to assess orders of magnitude of the phenomena. (auth)

18826 TEMPERATURE VARIATION OF THE RESONANCE LEVEL WIDTH AND SHIFT ON MOTION OF A PARTICLE IN A CRYSTAL. Afanasev, A. M.; Kagan, Yu. Zh. Eksp. Teor. Fiz., 52: 191-207(Jan. 1967). (In Russian).

The effect of the regularity of a crystal lattice on the change of the resonance nuclear level parameters in the presence of lattice oscillations is investigated by taking into account spin and isotopic incoherent scattering. A consistent deduction of the dynamic equation set for particles moving in regular crystals is presented for particles satisfying the Schroedinger equations as well as for γ quanta and x rays. The effect of variation of the resonance level parameters on the coefficients of the set is analyzed for the case of resonance interaction. The temperature dependence of the dynamic system parameters during potential scattering (neutrons of x rays) is also considered by consistently taking into account coherent particle scattering processes involving excitation (absorption) of phonons. (auth)

18827 ELECTRON SPIN RESONANCE ABSORPTION SPECTRA OF CO_3^- AND CO_3^{3-} MOLECULE-IONS IN IRRADIATED SINGLE-CRYSTAL CALCITE. Serway, R. A. (Illinois Inst. of Tech., Chicago. IIT Research Inst., Chicago); Marshall, S. A. J. Chem. Phys., 46: 1949-52(Mar. 1, 1967).

Single crystals of x- and γ-irradiated calcite reveal a number of paramagnetic defect centers, two of which have been tentatively identified as the CO_3^- and CO_3^{3-} molecule-ions. The ESR absorption spectrum of what is believed to be the CO_3^- molecule-ion is found to have symmetry about the calcite [111] direction with spin-Hamilton parameters given by $g_{||} = 2.0051$, $g_\perp = 2.0162$, $A_{||} = 13.1$ Oe, and $A_\perp = 9.4$ Oe. The corresponding parameters for what is believed to be the CO_3^{3-} molecule-ion, which also exhibits symmetry about the crystal [111] direction, are given by $g_{||} = 2.0013$, $g_\perp = 2.0031$, $A_{||} = 171.22$ Oe, and $A_\perp = 111.33$ Oe. The parameters of these two spectra are discussed and compared with those reported for the isoelectronic NO_3 and NO_3^{2-} species. Optical measurements reveal two absorption bands, one at 6500 Å and another at 4850 Å. The longer-wavelength band exhibits anisotropy and is found to have temperature-dependent decay characteristics similar to those of the CO_3^- molecule-ion ESR spectrum. An activation energy of 0.12 eV is obtained for this center. Thermal decay data suggest that the shorter-wavelength band is not associated with either of these paramagnetic species. (auth)

18828 EPR IN ELECTRON IRRADIATED GERMANIUM. Trueblood, Donald Lloyd. Lafayette, Ind., Purdue Univ., 1966. 91p.

Thesis.

Spin resonance has been studied in oxygen-free p-type germanium bombarded by 4.5-MeV electrons. The samples were bombarded and stored at 77°K, and measurements were made at liquid-helium temperatures with a superheterodyne spectrometer operating at about 9500 Mc. Essentially the same resonance spectra appeared in both undoped and gallium-doped germanium samples that initially had room-temperature resistivities in excess of 40 ohm-cm. A total of seven isotropic lines was observed along with one anisotropic set that was predominant. No resolved hyperfine spectra were observed. The anisotropic set, which has a line width of 70 gauss, represents a spin-$\frac{1}{2}$ center, designated Ge-P1, whose g-tensor has ⟨100⟩⟨011⟩ symmetry, with $g[01\bar{1}] = 2.025$, $g[011] = 1.629$, and $g[100] = 1.732$. Its production rate is approximately 1.6 defects/cm^3 per e/cm^2. This center appears to be a long-lived electron trap. The resonance signal gradually decreases when the sample is stored several days at 77°K. By warming the sample slightly the emptying of the traps is accelerated, and at 135°K the traps empty in minutes. The resonance signal returns when the traps are repopulated by a short burst of ionizing electron irradiation at 77°K. When the sample is warmed above 230°K the center loses its trapping property and is assumed to have disappeared or changed its form. An analysis of the g-shift and the trapping behavior is not sufficient to give a definite microscopic model of the Ge-P1 center; however, the high degree of symmetry of the g-tensor suggests that the structure of the defect is simple. (Dissertation Abstr.)

18829 SUB-THRESHOLD AND ABOVE-THRESHOLD ELECTRON DAMAGE IN N-TYPE GERMANIUM. Chen, Yok. Lafayette, Ind., Purdue Univ., 1966. 88p.

Thesis.

The accepted value of the threshold energy for production of lattice displacements in Ge by electron bombardment is 355 keV However, damage is produced, at 78°K, by subthreshold-energy electrons in n-type Ge crystals grown in H_2 atmosphere, but not

in vacuum-grown crystals. Heat treatment of a hydrogen-grown crystal in either vacuum or hydrogen atmosphere at 450 to 500°C for 24 hours renders the crystal immune to subthreshold damage without changing the electrical conductivity. Subthreshold defects have different electrical properties and annealing behavior than defects produced by above-threshold electrons, suggesting that the former are not due to lattice displacements. The production of subthreshold damage appears to go to zero at about 40 keV There is no dependence of damage production on crystal orientation. The removal rates at 78°K are larger than at 273°K. Crystals grown in D_2 exhibit little or no damage. It is concluded that subthreshold damage is due to relocation of an impurity atom in the lattice. This impurity is most probably hydrogen. The surprising lack of damage in deuterium-grown crystals is suggestive of the possibility that the relocation mechanism is an ionization effect. The dependence of damage production on bombardment energy is consistent with an ionization-induced process except that such a process should have a "zero energy" threshold. A model is proposed to explain the 40-keV apparent threshold. Tests for the validity of the model are suggested. Based on knowledge of the subthreshold effect, improved measurements of the orientation dependence of damage on energy above the displacement threshold are made, using thin ⟨111⟩- and ⟨100⟩-oriented wafers. The results are in general agreement with those of Brown and Augustyniak, but the orientation dependence near the threshold is more pronounced. (TSS)

18830 PULSE AND RADIATION ANNEALING OF N-TYPE GERMANIUM. Naber, James Allen. Lafayette, Ind., Purdue Univ., 1966. 71p.

Thesis.

It has been suggested that the defect responsible for the 65°K annealing stage in n-type germanium is a close-pair configuration of a vacancy and interstitial whose recombination rate is governed by the excitation of a defect-stabilizing electron from a level in the forbidden energy gap. If this is so, at some elevated temperature greater than 65°K, this vacancy–interstitial recombination should take place by a direct recombination of the vacancy–interstitial before the stabilizing electron is excited from the defect. Experiments were undertaken to attempt to observe this "high-temperature" annealing of the 65°K stage defect. The irradiated sample is heated by a 15-microsecond pulse of current to temperatures >100°K and the annealing is monitored by changes in the electrical resistivity. The kinetics of the pulse annealing are not consistent with direct vacancy–interstitial recombination, but give a first order reaction with an activation energy of 0.066 ± .005 eV and frequency factor of 10^7 sec^{-1}. Only $\frac{1}{2}_{.7}$ of the total electrical resistivity recovery produced by the heating pulse is observed with the above kinetics. The unobserved portion of the recovery occurs too rapidly to be observed and is believed to take place during the heating pulse. The pulse annealing characteristics are different from the 0.1-eV and 10^3 sec^{-1} isochronal annealing characteristics of the 65°K defect. However, the characteristics of the pulse annealing are very similar to the 35°K defect annealing observed with stored energy release measurements. It is concluded that the 35°K and 65°K stage defects anneal by close-pair vacancy–interstitial recombination where the 35°K stage defect is a single acceptor and the 65°K stage defect is a double acceptor. In the process of annihilation, the 65°K defect passes through a state that is similar, or possibly even identical to the configuration of a 35°K defect. The radiation annealing of the 65°K stage defect as a function of temperature is also investigated. The 65°K stage defect radiation anneals below 36°K but the flux rate of annealing is very low. Above 36°K the flux rate of annealing increases very rapidly. This behavior is consistent with the 65°K stage defect annealing through an intermediate state similar to the 35°K stage defect configuration. (Dissertation Abstr.)

18831 MAGNETIC INTERACTION IN THE DHVA EFFECT IN BERYLLIUM. Plummer, Robert Daniel. Cleveland, Case Inst. of Tech., 1965. 68p.

Thesis.

The influence of magnetic interaction in the DHVA effect in beryllium arising from the cigar-shaped portions of the Fermi surface was examined by the method of field modulation with coherent detection in the range of 1.85 to 4.2°K. Both rod and disk shaped samples were used. The general features of the data concerning harmonic content in the high temperature region and the presence of saturation effects are in accord with the theory of Shoenberg and Pippard and the generation of a difference frequency within the crystal by magnetic interaction is confirmed. The apparent discrepancies in harmonic content at low temperatures seem to be linked to the presence of a strong natural second harmonic which may also offer an explanation for the absence of the predicted hysteresis effect. (Dissertation Abstr.)

18832 RADIATION DAMAGE IN GERMANIUM. Dayal, Yogeshwar. Chicago, Illinois Inst. of Tech., 1965. 216p.

Thesis.

High-resistivity (almost intrinsic) n-type germanium oriented in the ⟨111⟩ direction, was irradiated with several ions in the energy region 20 to 140 keV. The effect of the bombardment on the electrical conductivity was studied, and measurements were made as a function of ion, energy, and dose. The number of carriers produced per incident ion for the various bombardments was found to be in the ratio of the expected number of atoms displaced per incident ion calculated by using Seitz's random-lattice model. This indicates that the difference in the effectiveness of the various ion in changing the conductivity, can be explained by a difference in the number of displacements produced by these ions. Several irradiated specimens, representatively chosen, were etched in stages till the damaged layer was removed, in order to determine the conductivity profile in the damaged region and the depth of the damaged region. The conductivity profiles, at saturation, were found to be uniform only for proton bombardments, and became less and less uniform as the mass of the bombarding ion increased. The maximum conductivity in the damaged region increased with the mass of the bombarding ion. A model involving the separation of interstitials and vacancies in the collision process has been advanced. The total depth of the damaged region for He^+, Ne^+, and Ar^+ bombardments was many times greater than the expected depths of penetration in amorphous germanium. An anomalous dependence of the total depth on the mass of the bombarding particle was observed for H^+, D^+, and He^+ bombardments. A channelling mechanism has been put forward whereby a certain percentage of the incident ions exhibit and "extraordinary" range and the remainder an "ordinary" range. (TSS)

18833 THE MULTIPLE BRAGG REFLECTION OF NEUTRONS IN MOSAIC CRYSTALS. Werner, Samuel Alfred. Ann Arbor, Mich., Univ. of Michigan, 1965. 202p.

Thesis.

The multiple-Bragg-reflection (secondary extinction) problem in mosaic crystals of various shapes is solved for incident neutron beams of finite size. The assumption is made (as has generally been done) that primary and secondary extinction are separable. Applications to the theory of monochromatization of neutrons is made. The solution for the diffracted current density J_D takes the form of an infinite series of modified Bessel functions which reduces to simple forms for certain finite geometries. For the particular problem of a delta function beam striking a semi-infinite crystal this series is finite and contains only two terms. This solution is used as a Green's function to find the diffracted current density resulting from an incident beam which is distributed in angle, energy, and space. The results for the semi-infinite crystal are generalized to include the case where the crystal is of finite thickness. The coupled partial differential equations describing the multiple reflection process are put in integral form and solved for certain illustrative examples, namely: diffraction by transmission through a slab crystal, and diffraction in pillar-shaped crystals (for which secondary extinction coefficients are calculated). Terms in these solutions can easily be identified as due to once-, twice-, ... n-times reflected neutrons. The experimental work on Pb, Zn, NaCl, Cu, and Si single crystals indicated that the actual mosaic structure of crystals has large holes very closely separated in the mosaic orientation angle Δ, and consequently, the calculation of the probability for Bragg scattering per unit path from the width of double-crystal-rocking curves is not meaningful. (Diss. Abstr.)

18834 CHANNELING OF CHARGED PARTICLES IN SINGLE CRYSTALS. Appleton, B. R. New Brunswick, N. J., Rutgers State Univ., 1966. 221p.

Thesis.

Investigations have shown that energetic protons penetrating thin single crystals at small angles to the low-index crystal directions exhibit anomalous energy loss rates and scattering patterns. Well collimated (0.03 to 0.15 degrees full angle of divergence) proton beams with energies from 3.0 to 11.0 MeV were used to investigate these directional effects for the (111), (110), and (100) planes, and [110] axis, of 30- to 50-micron thick silicon crystals. Protons incident far from any low-index directions showed particle energy and intensity distributions equivalent to those expected for an amorphous silicon sample of the same mass density. For such crystal orientations the transmitted protons were unaffected by the ordered arrangement of the crystal lattice and were referred to as normal particles. When the beam was incident at small angles to the low-index directions some of the emerging protons lost anomalously small amounts of energy (low-loss particles) while others lost anomalously large amounts (high-loss particles) compared to the normal energy loss. A systematic investigation was made of the dependence of the anomalous-energy-loss particles on angle of incidence of the beam relative to the crystal planes and on angle of emergence of the anomalous particles relative to the planar directions. The results are consistent

with the following model proposed to explain the origin of the high- and low-loss particles. Protons within a limiting angle of incidence to the planes, ψ_c, are confined by a series of correlated small angle scatterings from the atoms in the planes to the open channels between the planes. The oscillatory trajectories of these channeled particles are in regions of low electron density (between the atom planes) and thus lose less energy than normal. The high-loss particles are most probable for angles of incidence and emergence $>\psi_c$ and they originate from strong multiple scattering in the dense planar regions. It was found that planar, as opposed to axial, channeling was the dominant process and that the amount of purely axial channeling was small even when incidence was along an axis. The least energy loss and straggling for channeled protons in silicon and germanium was measured. A mechanism of least energy loss was proposed, which assumed that the energy loss of the least-deflected protons was due to interactions with the valence electrons only. The rule of equipartition of energy loss between close and distant collisions was tested utilizing least-energy-loss measurements and was shown to be invalid as applied to atomic systems. (TSS)

18835 X-RAY IRRADIATION EFFECTS IN STATIC AND SLIDING FRICTION OF POTASSIUM CHLORIDE. Jirgal, George H. Jr. Chicago, Illinois Inst. of Tech., 1965. 76p.

Thesis.

The forces of static and sliding friction between mechanically polished, x-irradiated KCl were found to satisfy the equations: $F\ (static) = AN^{\frac{1}{3}} + BN$ and $F\ (sliding) = B'N + D'N^{\frac{1}{3}}$ where F is the force of friction, N is the normal force, and A, B, B', and D' are numerical coefficients. Various models of friction were examined, and it was shown that both the functional relationships between friction and the normal force and between the changes in the numerical coefficients and the F-center concentration are consistent only with a modification of the plastic shearing theories of Bowden and Tabor and of Rabinowicz. In this modification, the coefficients are given by $A/B = MW/p^{\frac{1}{3}}$, $B = B' = s/p$, and $D' = M'p^{-\frac{1}{3}}$, where s is the shear strength of the juctions of the contacting asperities, p is the yield pressure of tha asperities, W is the work of adhesion per unit area, and M and M' are numerical constants. The changes of the frictional coefficients A/B, B, B', and D' were proportional to the square root of the F-center concentration induced by the x irradiation, but remained unaffected when the F centers were photobleached. The changes were consistent with the theory of defect hardening proposed by Fleischer and the flow stress experiments of Nadeau and of Sibley and Sonder. (Dissertation Abstr.)

18836 ENERGY DISTRIBUTIONS OF ENERGETIC ATOMS IN IRRADIATED MEDIA. Felder, Richard Mark. Princeton, N. Y., Princeton Univ., 1966. 150p.

Thesis.

The energy-dependent collision density is discussed and evaluated for a system in which hot atoms emanate from a homogeneous monoenergetic source and lose their energy in successive binary elastic collisions with thermal atoms. Results obtained for the case where the hot and thermal atoms are of different species are applied to the kinetic theory of hot-atom reactions developed by Wolfgang and coworkers. It is shown that Wolfgang's assumption that the collision density in the absence of reactions varies as $1/E\alpha(E)$, where α is the mean logarithmic energy decrement of the hot atoms evaluated at energy E, is generally reasonable, but that significant error may be introduced if the energy dependence of α is not explicitly taken into account. The calculations are performed for a class of interaction potentials that includes the inverse power potential $V(r) = K/r^s$. The degree of scattering anisotropy is directly related to the exponent s of the potential: $s = \infty$ corresponds to isotropic (hard-sphere) scattering, and $s = 1$ represents the extreme anisotropy of pure coulombic scattering. A quantitative estimate of the influence of scattering anisotropy on the collision density is thus provided by the results obtained. Collision densities are also determined for a system in which the hot and thermal atoms are of the same species. The species results for the inverse power potential with an exponent of s are that for unlike species of hot and thermal atoms the collision density varies as $E^{-1} + {}^{2/s-1/(s-1)}$, and for like species the variation is as $E^{-2} + {}^{2/s-1(s-1}$; numerical solutions of the Boltzmann equation are given, which confirm these analytical results. The results for the case of like species are applied to the calculation of the number of displaced atoms produced within a solid by a primary energetic atom. (Dissertation Abstr.)

18837 CATHODOLUMINESCENCE OF RUBY. Levine, Martin William. Lafayette, Ind., Purdue Univ., 1965. 156p.

Thesis.

The fluorescence of ruby produced by bombardment with electrons in the energy range from 5 to 25 keV was experimentally investigated. Visible and near-infrared fluorescence spectra at both low and high current densities were compared with the spectra produced by optical excitation. The intensity of R-line fluorescence was studied as a function of beam current, beam voltage, and temperature. The rate of decay of the red fluorescence was examined as a function of beam voltage and temperature. It was found that the major features of the electronically induced fluorescence spectra in the range 0.3 to 1.2 microns were independent of beam current and identical to the optically stimulated spectra. However, at high current densities a band structure centered at 3500 Å increases in relative intensity because of the saturation of the R-lines and the vibronic satellites. The R-line fluorescence saturated at a beam current density of approximately 5 mA/cm^2, independent of beam voltage. Measurements of the absolute fluorescent power emitted in the R_1 and R_2 lines indicate that the saturation is a result of the activation of nearly all of the chromium centers within the penetration limit (3.2 microns at 20 kV) of the incident electrons. The absolute power measurements also showed that the fluorescence efficiency, the ratio of optical power radiated into the R-lines to electrical power in the beam, was slightly greater than 1%. The red fluorescence increased linearly with beam voltage above a threshold of approximately 5 kV. The fluorescence decay time of the R_1 lines was found to decrease slightly with increasing temperature; resonance radiation trapping, which tends to increase the observed decay time in optically excited samples, was not observed under electron-beam bombardment. The decay time appeared to increase with increasing beam voltage, from 4.0 msec at 7 kV to 5.0 msec at 18 kV. (Dissertation Abstr.)

18838 MOESSBAUER EFFECT IN GOLD MICROCRYSTALS. Marshall III, Samuel Wilson. New Orleans, La., Tulane Univ., 1965. 108p.

Thesis.

Small crystalline particles have lattice vibrational (phonon) spectra different from the bulk solid for two reasons: long wavelength phonons cannot be sustained in small crystals; and, a large percentage of the atoms in these small crystals reside on the surface, producing surface waves. If for a crystal of N atoms the number of lattice vibrational modes is 3N-6, then within the Debye continuum framework, a suitable distribution function containing surface modes for the phonons must be cut off at both a low frequency (temperature) and a high-frequency (temperature) limit. The fraction of gamma-ray emissions and absorptions occurring without recoil of the involved nuclei (the Mössbauer effect) depends on the phonon spectrum of the solid. An expression has been derived for this fraction using a phonon distribution function which accounts for crystal size. Thus the magnitude of the Mössbauer effect is a function of crystal size. The Mössbauer effect was observed for ^{197}Au nuclei in crystals 200 and 60 A in diameter grown in a hydrosol and bound in gelatin. Measurements of the effect were made from 4.2 to 63°K while the platinum source was maintained at 4.2°K. These measurements indicate that the surfaces of the crystals are loosely bound to the gelatin, and they yield characteristic temperatures of 8 and 163°K, and 23 and 173°K, respectively. These figures are to be compared to 0 and 173°K found for bulk gold. (Dissertation Abstr.)

18839 CHARACTERISTIC ELECTRON ENERGY LOSSES IN LAYERED METALLIC THIN FILMS. Miller, William Robert Jr. Newark, Del., Univ. of Delaware, 1965. 124p.

Thesis.

The characteristic electron energy loss spectra of layered films of Bi and Mg have been measured using a retarding potential electron energy analyzer with an electrically differentiated output to obtain the energy loss distribution directly. A new loss, that was not observed on single layer films of Mg or Bi, was found at 12.9 ± 0.2 eV. This loss can be interpreted as a surface plasma loss at the metal–metal interface. A surface loss in Al/Mg films was not reproducible, but a new loss was observed at 26.4 eV which can be interpreted as a single Al loss (15.4 eV) plus a single Mg loss (10.9 eV). Chemical and physical processes such as changes in composition and aggregation at the Al/Mg interface during both the preparation and measurement of the sample may alter the interface enough to decrease the intensity of the surface plasma loss. (Dissertation Abstr.)

18840 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE PHYSICS OF SEMICONDUCTORS, KYOTO, 1966. J. Phys. Soc. Jap., 21: Suppl., 1-780(1966). (CONF-660949).

Papers are included on band theory, optical properties-lattice, optical properties-electronic, exciton, magneto-optics, impurity state, recombination, transport phenomena, quantum transport, hot electrons, electron-phonon interaction, current instability, impurity conduction, tunneling, magnetic semiconductors, superconductivity, semimetals, plasma instability, and magneto-plasma and magneto-acoustic phenomena. (M.H.R.)

Theoretical Physics

Refer also to abstracts 18945 and 19027.

18841 (JINR-P4-3175) ZADACHA DVUKH TSENTROV KVANTOVOI MEKHANIKI. III. TABLITSY TERMOV. (Two-Center Problem of Quantum Mechanics. III. Term Tables). Ponomarev, L. I.; Puzynina, T. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 67p. (In Russian). Dep. mn.

The tables are listed which present the results of calculations for some terms of the two-center problem of quantum mechanics which were obtained by the method suggested in the previous papers. (auth)

18842 (NP-16532) WHEN DOES THE DYNAMICAL SYSTEM TURN INTO THE STATISTICAL ONE? Communication at the International Congress of Mathematicians, Moscow, 1966. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1966. 13p. Dep. mn.

Some results of the analytical and numerical investigations concerning the appearance of stochasticity in a conservative system of the type of weakly coupled nonlinear oscillators are presented. The term "stochasticity" denotes all the statistical properties of the dynamical system. At present one is still unable to understand completely the nature of statistical laws and, hence, the conditions of their appearance. Nevertheless, there is apparently no doubt now as to which type of the mechanical motion is the basis for the appearance of the "real" stochasticity or, at least, of its very similar imitation. That is the mixing motion with positive Kolmogorov entropy. So when the word "stochasticity" is used, just this type of the motion is meant. The main problem to be solved is the obtaining of stochasticity criterion, e.g., finding out the conditions under which the statistical laws start to act in a dynamical system. From the standpoint of applications, the stochasticity is the most dangerous instability of nonlinear oscillations. (auth)

18843 QUANTUM HARD-SPHERE GAS IN THE LIMIT OF HIGH DENSITIES WITH APPLICATION TO SOLIDIFIED LIGHT GASES. Cole, R. K. Jr. (Stanford Univ., Calif.). Phys. Rev., 155: 114-21(Mar. 5, 1967).

The properties of a quantum hard-sphere gas in the limit of high densities are investigated, with particular emphasis on the ground-state energy per particle This has the asymptotic form $(E_0/N)_\rho \simeq \rho_s(\hbar^2/2m)A\ (\rho^{-1/3} - \rho_0^{-1/3})^{-2}$, as deduced from the Heisenberg principle, and is independent of particle statistics. A model of hard spheres arranged in a simple cubic lattice is solved by reduction to the known one-dimensional case, and gives $A_{sc} = \pi^2$. For more realistic close-packed systems it is estimated that $A_{cp} \approx 10$ to 15. This form connects smoothly to the well-known low-density gas-parameter expansions. Phonon properties in the Debye approximation are derived. The model is applied to the zero-point kinetic energies of hexagonal-centered-cubic (hcp) ^{3}He, ^{4}He, H_2, and D_2, as determined from pressure data. The helium data give $A \approx 15.7$, the hydrogen data $A \approx 15.9$. The fitted hard-core diameters, 1.73 and 1.90 Å, respectively, are smaller than expected from accepted potentials; this is discussed. Thermodynamics of the simple cubic system give $c_v \propto T$ for both bosons and fermions, which may explain the anomalous (non-Debye) heat capacities of solid ^{3}He and ^{4}He at low temperatures. (auth)

18844 RELATIVISTIC STATISTICAL MECHANICS AND BLACKBODY RADIATION. Eberly, Joseph H.; Kujawski, Adam (Univ. of Rochester, N. Y.). Phys. Rev., 155: 10-19(Mar. 5, 1967).

A manifestly Lorentz-invariant generalization of the Gibbs's canonical density operator is derived for the free fields of quantum electrodynamics from the maximum-entropy principle. Known results for the energy density, entropy, and other thermodynamic functions of blackbody radiation are very simply rederived. Use of the invariant density operator makes it clear that, contrary to recent assertions of Ott and others, it is not necessarily most natural to assume that temperature transforms like an energy. What is more to the point, it is shown that the concept of temperature in a moving system can be eliminated altogether if desired. Temperature may be conveniently considered as a purely rest-frame concept. The invariant density operator is then used to investigate the second-order two-point space–time correlation functions of the blackbody radiation field. The recent results of Mehta and Wolf and others are generalized to an arbitrary uniformly moving coordinate system, and the most interesting cases of pure temporal and spatial coherence are presented graphically. Two examples are given in which a moving observer measures a higher degree of coherence than he would in the rest system. Some remarks are made concerning the Gaussian nature of the phase-space distribution function, and the consequences for higher-order correlation functions in a moving frame are discussed briefly. (auth)

18845 ENERGY OF A CLOSED UNIVERSE. Graiff, Franca (CNR, Rome). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 50-7(Jan. 1966). (In Italian).

The problem of determining the "energy-momentum" density and the "energy-momentum" vector in the closed universes of general relativity is considered. In order to define in covariant form the "energy-momentum" vector, "two-event" tensors are considered. (auth)

18846 HOMOGENEOUS LICHNEROWICZ UNIVERSES. Ozsvath, Istvan (Southwest Center for Advanced Studies, Dallas). J. Math. Phys. (N. Y.), 8: 326-44(Feb. 1967).

Lichnerowicz has developed a general-relativistic theory of an electrically charged fluid with infinite conductivity. No exact solutions of the corresponding Einstein–Lichnerowicz equations have previously been given. The present paper establishes homogeneous solutions of these equations. (auth)

18847 RELATIONS BETWEEN FIELD-PLUS SOURCE AND FOKKER-TYPE ACTION PRINCIPLES. Anderson, James L. (Stevens Inst. of Tech., Hoboken, N. J.); Schiminovich, Samuel. J. Math. Phys. (N. Y.), 8: 255-64(Feb. 1967).

The problem of constructing a Fokker-type action that will yield equations of motion for the sources of an original field-plus-source system is considered. It is shown that such an action can be constructed for a large class of systems by substituting for the fields appearing in the original field-plus-source action a solution of the field equations in terms of the source variables provided that certain conditions are satisfied. In general, these conditions will be satisfied only by half-advanced, half-retarded-type solutions of the field equations and then only for a field-plus-source Lagrangian that differs from the usual one by a complete divergence. The problem of constructing a Fokker action for a system that possesses a gauge-type covariance is complicated by the existence of differential identities that are satisfied by the left-hand sides of the field equations and that arise as a consequence of the gauge covariance. These difficulties can be overcome by the introduction of gauge conditions on the field variables. The problem of finding solutions to the field equations suitably modified with the help of the gauge conditions that satisfy both the gauge conditions and the conditions for the construction of the Fokker action is discussed. As an application of the method, the Fokker action of electrodynamics using a number of different gauge conditions were obtained, arriving thereby at several different expressions for this action. The construction of a Fokker action when the field equations are solved by an approximation method was also considered. In such cases it was shown that to determine the Fokker action up to the nth order of the approximation it is only necessary to solve the field equations up to order $\frac{1}{2}(n + 2)$ or $\frac{1}{2}(n + 1)$ for n even or odd, respectively. The method is then applied to obtain the Darwin action of electrodynamics. (auth)

18848 MAXIMAL ANALYTIC EXTENSION OF THE KERR METRIC. Boyer, Robert H. (Univ. of Liverpool); Lindquist, Richard W. J. Math. Phys. (N. Y.), 8: 265-81(Feb. 1967).

Kruskal's transformation of the Schwarzschild metric is generalized to apply to the stationary, axially symmetric vacuum solution of Kerr, and is used to construct a maximal analytic extension of the latter. In the low angular momentum case, $a^2 < m^2$, this extension consists of an infinite sequence Einstein–Rosen bridges joined in time by successive pairs of horizons. The number of distinct asymptotically flat sheets in the extended space can be reduced to four by making suitable identifications. Several properties of the Kerr metric, including the behavior of geodesics lying in the equatorial plane, are examined in some detail. Completeness is demonstrated explicitly for a special class of geodesics, and inferred for all those that do not strike the ring singularity. (auth)

18849 INSTANTANEOUS ACTION-AT-A-DISTANCE IN CLASSICAL RELATIVISTIC MECHANICS. Hill, Robert Nyden (Univ. of Delaware, Newark). J. Math. Phys. (N. Y.), 8: 201-20 (Feb. 1967).

The possibility of describing orbits in classical relativistic mechanics in instantaneous action-at-a-distance fashion by second-order differential equations (as in Newton's gravitational theory) is investigated with particular emphasis on the two-body problem of classical relativistic electrodynamics. Differential conditions are stated to guarantee world-line invariance and form-invariance of the equations of motion under Lorentz transformation for such a description of an N-particle system in three dimensions. A pair of integrodifferential equations for the equations of motion are derived to provide an explicit means of passing from a description via direct interaction along light cones to an instantaneous action-at-a-distance description for a two-body problem These integrodifferential equations are applicable to the two-body problem of classical electrodynamics with either retarded inter-

actions and radiation damping or with half-advanced plus half-retarded interactions. (auth)

18850 NOTE ON THE ROBINSON–TRAUTMAN SOLUTIONS. Foster, J. (London Univ.); Newman, E. T. J. Math. Phys. (N. Y.), 8: 189-94(Feb. 1967).

A procedure is given which enables one to construct all the type-N Robinson–Trautman solutions and an infinite class of type-III solutions. Some approximate solutions, consistent with the Bondi–Sachs radiation conditions for bounded source fields, are also given. These approximate solutions, obtained by perturbing the Schwarzschild solution, are Schwarzschild in the asymptotic future. It is also shown that there exists an infinity of exact solutions which are Schwarzschild in the asymptotic future. (auth)

18851 EXACT SOLUTION OF EINSTEIN'S GRAVITATIONAL EQUATIONS AND ITS APPLICATION TO GROUPS OF GALAXIES AND QUASI-STELLAR RADIO SOURCES. Kalitzin, N. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 18: 505-8 (1965).

An exact solution of Einstein's gravitational equations for the problem of insular spherically symmetric accumulation of matter in empty space was obtained previously. A model is investigated which features a spherical region G with spherically symmetric distribution of matter. Inside region G the pressure is assumed to be zero and the density to depend only on time, while outside the density of matter vanishes and the field is asymptotic to Euclidean space at infinity. An exact solution of the gravitational equations is obtained and applied to groups of galaxies and quasars. (W.D.M.)

18852 DERIVATION OF THE SPIN–ORBIT INTERACTION. Farago, P. S. (Univ. of Edinburgh). Amer. J. Phys., 35: 246-9(Mar. 1967).

Many find it paradoxical that spin-orbit coupling is discussed in nonrelativistic quantum mechanics although it is usually said to be a consequence of relativity. The resolution of this paradox is discussed. The Thomas precession is related to the commutation properties of the matrices used to describe the resultant of two consecutive Lorentz transformations without rotation; the frequency of the Thomas precession is derived on this basis. (auth)

18853 INVARIANCE PRINCIPLES IN CLASSICAL AND QUANTUM MECHANICS. Chern, Bernard (Univ. of Florida, Gainesville); Tubis, Arnold. Amer. J. Phys., 35: 254-70(Mar. 1967).

A simple, unified discussion of invariance principles in nonrelativistic classical and quantum mechanics is presented. In particular, space-translation, space-rotation, space-inversion, Galilean, and time-reversal invariance are discussed from the point of view of possible physical motions. In addition, there is a discussion of the classical connection between space inversion, time reversal, and what may be considered a type of "charge conjugation." (auth)

18854 WAVE EQUATION FOR MASSIVE PARTICLES OF ARBITRARY SPIN. Dowker, J. S. (Univ. of Manchester, Eng.). Proc. Roy. Soc. (London), Ser. A, 297: 351-64(Mar. 7, 1967).

A wave equation is given which, in the force-free case, describes a particle of unique spin and mass and which remains consistent when interactions are included. The equation is simple in the sense that it involves only matrices which satisfy the Pauli commutation rules. This simplicity is achieved at the expense of extending the particle field vector from $2j + 1$ components to $4j$. The extra $2j - 1$ components remove the inconsistency of the interacting system. In the force-free case these additional components vanish and the resulting equations are equivalent to those of Dirac, Fierz, and Pauli. For the interacting system, the extra components do not vanish. The second-order propagation equations are deduced in the case of external electromagnetic and gravitational fields. (auth)

18855 RECENT DEVELOPMENTS IN GENERAL RELATIVITY Kilmister, C. W. (Univ. of London). Advance. Sci., 23: 606-10 (Mar. 1967).

The subject is reviewed under the following headings: Introduction; Timing of Distant Events; Newton's Theory of Gravitation; Principle of Equivalence; Critical Radius; Possibility of Real Collapse; Nature of Critical Radius; Causality in Question; Can Quantum Mechanics be Consistent with Gravitation? (UK)

18856 ON THE APPLICATION OF BARGMANN HILBERT SPACES TO DYNAMICAL PROBLEMS. Schweber, S. (Brandeis Univ., Waltham, Mass.). Ann. Phys. (N. Y.), 41: 205-29(Feb. 2, 1967).

The realization $a^* \rightarrow z$, $a \rightarrow d/dz$ on a Hilbert space of entire functions (the Bargmann Hilbert space) of the operators a, a^* which obey the commutation rules $[a, a^*] = 1$ is applied to some simple dynamical problems. The case of a spin-$\frac{1}{2}$ system coupled to a single mode through an interaction term of the form $\kappa(a + a^*)\sigma_x$ is treated in some detail to illustrate the type of analysis involved. (auth)

18857 RELATIVE ENERGY OF THE PLANE GRAVITATIONAL WAVES. Khiet, Vu Thanh. Vestn. Moskov. Univ., Ser. III, Fiz. Astron., No. 3, 17-25(May-June 1966). (In Russian).

Energies of Synge plane gravitational waves in relation to various reference points were calculated using the Yu. A. Rykov (Ann. Phys. 7: 12(1964)) concept of relative gravitational fields. It was found that the sign and magnitude of the energy are functions of the position of the reference point. (tr-auth)

18858 BASIS FOR SPECIAL RELATIVITY THEORY PROVIDED BY EXPERIMENTS IN HIGH-ENERGY PHYSICS. Blokhintsev, D. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Usp. Fiz. Nauk, 89: 185-99(June 1966). (In Russian).

A large number of experiments in high-energy physics are reviewed for the purpose of checking the degree of support that they can provide for the special theory of relativity. The theoretical foundations for testing the special theory of relativity in the domain of high energies and small dimensions are reviewed from the point of view of numerous elementary premises of elementary-particle theory such as microcausality, conservation laws, and the various parities. The principles that might be verified on the basis of recent experimental data are microcausality, the disperion relations, the asymptotic relations between various cross sections, and homogeneity and isotropy of space-time. Other possible checks on the theory of relativity in light of present experimental results are also mentioned. It is concluded that the presently known set of facts in dimensions close to 10^{-15} cm (lab.) or 10^{-14} cm (c.m.s.) do not contradict relativistic kinematics, which hold on the average with an accuracy of ~1%. The dependence of mass on velocity has been verified with higher accuracy, up to 0.01%. Possible large deviations from relativistic kinematics are conceivable, but these have low probability and have not been investigated. The only troublesome aspect is the situation with local field theory, which is closely related to the assumed form of geometry and to causality. Asymptotic cross sections in the region of 20 GeV do not approach one another as expected, and a comparison of presently known data on the forward scattering of high-energy pions does not agree with the results of calculations by means of dispersion relations. This calls for an increase in the measurement accuracy. If this disagreement between theory and experiment is confirmed, this would serve as a serious basis for a radical reevaluation of the basic postulates of modern special relativity theory. (ATD)

18859 NON-RELATIVISTIC QUANTUM THEORY OF HARMONICS IN THE SCATTERING OF ELECTROMAGNETIC WAVES BY FREE ELECTRONS. Prakash, Hari; Vachaspati (Univ. of Allahabad, India). Indian J. Pure Appl. Phys., 5: 21-2(Jan. 1967).

The scattering cross section was calculated for the second harmonic in the scattering of electromagnetic waves by free electrons, using the non-relativistic field theory. The results are found to be the same as reported earlier by Vachaspati [Phys. Rev., 128: 664(1962); 130: 2598(1963)] and by L. S. Brown and T. W. B. Kibble [Phys. Rev., 133: A711(1964)]. (auth)

18860 GRAVITATIONAL FIELD EQUATIONS FOR SOURCES WITH AXIAL SYMMETRY AND ANGULAR MOMENTUM. Matzner, Richard A.; Misner, Charles W. (Univ. of Maryland, College Park). Phys. Rev., 154: 1229-32(Feb. 25, 1967).

The investigation of stationary axially symmetric gravity fields leads to a reduced system involving two field variables which describe the "Newtonian" and the "rotation" part of the metric. A parametrization of this reduced problem is presented which exhibits a previously unnoticed symmetry. Although the symmetry group [isomorphic to homogeneous Lorentz transformations on $(2 + 1)$-dimensional space] has a trivial action corresponding to unimodular linear transformations of the ϕt coordinate pair, its existence "explains" the existence of a very simple new Lagrangian for the reduced field equations, and the relatively simple form in which these equations (and the corresponding surface-independent flux integrals for mass and angular momentum) can now be written. (auth)

18861 STRUCTURE OF INVARIANCE GROUPS FOR LINEAR FIELD THEORIES. Steudel, H. (Grundlagenforschung der Theorie der Teilchen und Felder, Akademie der Wissenschaften, Berlin). Z. Naturforsch., 21a: 1826-8(Nov. 1966). (In German).

The Lie algebra U of the invariance group of any field theory with a homogeneous quadratic Lagrangian shows a remarkable structure: if D_1, D_2, D_3 are any three elements of U, then the expression $\frac{1}{2}(D_1D_2D_3 + D_3D_2D_1)$ also belongs to U. This general property allows, starting with known invariance transformations

or conservation laws, derivation of an infinite number of conservation laws. (auth)

18862 ANISOTROPIC EFFECT IN EINSTEIN'S THEORY OF GRAVITATION. Ruffer, Joachim (Univ., Freiburg i. B.). Z. Naturforsch., 21a: 1821-5(Nov. 1966). (In German).

The use of a Euclidean space in astronomy corresponds in the framework of general relativity to the introduction of a Euclidean "space of comparison." This method is generalized, and the motion of test particles in the Euclidean space of comparison is analyzed. The inertial mass of test particles is a tensor in the space of comparison. Independent of any Coriolis force, the mass tensor is able to cause anisotropy effects that can be observed in principle. (auth)

18863 ON THE MECHANICS OF RADIATION. Infeld, L. (Southwest Center for Advanced Studies, Dallas); Michalska-Trautman, R. Ann. Phys. (N. Y.), 40: 374-94(Dec. 1966).

A general scheme is formed to find the relation between the energy per unit time lost by a radiating particle and that spreading through space. This scheme is applied to the gravitational radiation of an electric charge moving in a uniform magnetic field. Under certain restricting conditions this radiation turns out to be of the eighth order. (auth)

18864 BEST ENERGY CRITERION AND THE PRINCIPLE OF COMPENSATION OF DANGEROUS DIAGRAMS. Kobe, Donald H. (Univ. of Uppsala). Ann. Phys. (N. Y.), 40: 395-415(Dec. 1966).

The compensation of the lowest-order dangerous diagram is analogous to a Hartree–Fock procedure to determine the coefficients for the Bogoliubov quasi particles. This procedure is generalized in analogy with the Brueckner extension of the Hartree–Fock procedure by replacing the potential with the reaction operator (t-matrix) to obtain the principle of compensation of dangerous diagrams (PCDD). The PCDD is expanded by time-dependent perturbation theory to third order, and it is shown that ladder diagrams are not important. (auth)

18865 A VARIATIONAL RELATIONSHIP FOR NONEQUILIBRIUM, REAL-TIME QUANTITIES. Craig, R. A. (Univ. of Illinois, Urbana). Ann. Phys. (N. Y.), 40: 416-33(Dec. 1966).

The functional dependence of the real-time self-energies $\Sigma^{\lessgtr}(p, \omega, R, T)$ and the incoherent part of the density–density correlation function $\rho_2(x, t, R, T)$ obtained as the analytic continuations of functions defined for imaginary times, are examined for normal systems of fermions interacting instantaneously. It is found that although the imaginary time functions can be expressed as functional derivatives of some quantity, the real time functions in general cannot. However, at low temperatures and for slowly varying fields, an approximate relationship of this form exists. The real-time functions generated in this way differ from the exact quantities by terms which vanish at low temperatures as $(KT/\mu)^3$ (auth)

18866 NEW WKB APPROXIMATE SOLUTION OF THE RADIAL SCHROEDINGER EQUATION FINITE AT THE TURNING POINTS. Tietz, T. (Univ., Lodz, Poland). J. Chem. Phys., 46: 2015-16(Mar. 1, 1967).

An approximate solution of the Schroedinger equation $y'' + \{(2m/\hbar^2)(E - V) - [l(l + 1)/r^2]\}y = 0$ is given, which is finite in the interval $0 \leq r \leq \infty$. (A.G.W.)

18867 ADVANCES IN THEORETICAL PHYSICS. VOLUME 1. Brueckner, Keith A. (ed.). New York, Academic Press, 1965. 331p. $12.00.

Separate abstracts were prepared for the six review articles in the major fields of theoretical physics, including elementary-particle theory, nuclear structure, hydrodynamics, geophysics, astrophysics, and numerical methods of mathematical physics. The volume is intended to give specialists ready access to important advances in other fields. (S.F.L.)

For abstracts of individual papers see: 18454, 18616, 18868, and 19326–19328.

18868 THE THEORY AND APPLICATION OF THE PADE APPROXIMANT METHOD. Baker, George A. Jr. (Los Alamos Scientific Lab., N. Mex.). pp 1-58 of Advances in Theoretical Physics. Vol. I. Brueckner, Keith A. (ed.). New York, Academic Press, 1965.

The convergence properties of sequences of Padé approximants are discussed. Also, a conjecture is stated and examples and counterexamples relevant to its validity and possible extension are given. Examples are given which illustrate that the Padé approximate method can be a highly efficient method of series summation. The generalization of the Padé approximant method to include power series coefficients at more than one point is described. (M.O.W.)

18869 AN APPROXIMATION TO THE ELECTRON GAS SLATER SUM IN THE FORM OF A BOLTZMANN FACTOR INVOLVING PAIR POTENTIALS. Dunn, Tucson. Gainesville, Fla., Univ. of Florida, 1966. 162p.

Thesis.

The Slater sum of a high-density quantum electron gas is approximated by an effective Boltzmann factor. The exponent of the effective Boltzmann factor is a sum of pair functions and is called the effective pair potential. Using the effective Boltzmann factor, the techniques recently developed for classical fluids are applied to obtain the equation of state and energy of the quantum electron gas. The effective pair potential is defined in such a way as to account for the deviations of the distribution of particles governed by quantum mechanics from those which are predicted if the particles obeyed classical laws of motion. These deviations arise from symmetry effects, diffraction effects, and the coupling between the two effects. The effective pair potential is divided into a part which accounts for symmetry and a part which accounts for diffraction. The coupling is treated as a perturbation. (Dissertation Abstr.)

18870 WKB APPROXIMATION FOR THE QUANTUM RADIAL DISTRIBUTION FUNCTION. Jaen, Jong Kook. Gainesville, Fla., Univ. of Florida, 1966. 240p.

Thesis.

The problem of equilibrium quantum-statistical mechanics is studied, and the purpose is six-fold: (1) The presentation of the fundamental ideas and conceptions of equilibrium quantum-statistical mechanics by taking advantage of the Dirac Ket-bra vector description. (2) The presentation of the natural arrival at the most basic conception of "the Neumann's statistical density operator" in quantum statistical mechanics starting from "the Born's density operator" in the Schrödinger–Heisenberg quantum mechanics by introducing a new conception of "trajectory of the state vector of the system" in Hilbert space. (3) The presentation of a new expansion theory of the quantum partition function and pair correlation function on the basis of the group-theoretical discussion of the symmetric group. (4) The presentation of a new expansion theory of the exchange effective potential formally universal for all the quantum mechanical systems of many particles. (5) The presentation of the second-order approximation of the quantum radial distribution function by the WKB approach within the framework of the Broyles program. (6) The presentation of the comparison of the theoretical result with the experimental result of the quantum radial distribution function of the neon fluid to testify to the order of the accuracy of the approximation theory. Finally, 15 graphs are added. The first three graphs represent the quantum effective potentials of the Lennard-Jones 6-12 potential and the modified Buckingham–Corner 6-exp potential, and the exchange effective potential of the neon quantum fluid at four temperatures. The second six graphs represent the classical- and quantum-theoretical radial distribution functions of four cases of temperatures and densities of particles compared with their experimental curves in the neon quantum fluid. The last six graphs represent the theoretical relative-intensity curves of the scattering x rays compared with their experimental curves at four cases of temperatures and densities of particles in the neon quantum fluid. The theoretical result is comparatively in good agreement with the experimental result. A conclusion is given in the last section for a better idea leading to a better solution to the problem concerned with this dissertation. The new hypervolume integrals appearing in the course of the treatment of this problem are probably useful for the treatment of other statistical-mechanical problems, and are presented in three appendices with their evaluated steps. (auth)

18871 OPERATIONAL APPROACH TO SPACE–TIME MEASUREMENTS IN RELATIVITY. Gautreau, Ronald Thomas. Hoboken, N. J., Stevens Inst. of Tech., 1966. 185p.

Thesis.

An operational procedure for making space and time measurements is developed. The method combines the radiogeodesy method of Fock with the light clock of Marzke and Wheeler and makes use of only light signals and material particles. When the operational procedure is utilized by free observers in flat space it is found that all the usual kinematic results of special relativity, e.g., time dilation and length contraction, are obtained. It is also shown how the measurement theory can be applied to uniformly accelerated observers in flat space. It is then demonstrated how the operational method can be used by arbitrary observers in arbitrary gravitational fields for local space–time measurements. The measurement theory is next employed to formulate gedanken experiments which are used to illustrate the principle of equivalence. Operational techniques for investigating properties of gravitational fields are developed. These techniques

are used to analyze in detail the spherically symmetric Schwarzschild field, with special emphasis being placed on investigating the Schwarzschild singularity. It is also indicated how the principle of equivalence together with appropriate postulates might be utilized for obtaining metric components. (Dissertation Abstr.)

18872 ASYMPTOTIC THEORY OF CHERENKOV RADIATION. Handelsman, Richard Allen. New York, New York Univ., 1965. 146p.

Thesis.

Recently developed methods of asymptotic analysis are applied to the problem of Cherenkov radiation. The mathematical description of this physical phenomenon is given by the integro-differential system of equations for the elctromagnetic field in a dispersive medium. The parameter λ is introduced into these equations, where λ is a characteristic frequency of the medium. It is for large λ that the asymptotic expansion of the electromagnetic field is sought. The problems of Cherenkov radiation in infinite homogeneous and inhomogeneous isotropic media are treated. The Cherenkov radiation that occurs when an electromagnetic source travels with constant speed along the axis of a cylindrical channel is determined. (Dissertation Abstr.)

18873 TWO-COMPONENT SPINORS IN THE HAMILTONIAN FORMULATION OF GENERAL RELATIVITY. Oliveira, Colber Goncalves. Syracuse, N. Y., Syracuse Univ., 1965. 96p.

Thesis.

It is known that the Riemann properties of the four-dimensional space can be obtained from a given field of four 2×2 spin matrices. With six 2×2 Hermitian matrices a canonical formalism is set up, following the methods originated by Dirac. It is shown that a complete set of dynamical variables can be constructed which are related to each other by a total number of ten constraints at each point of the three-dimensional hypersurface where the state of the system is defined. The Hamiltonian of the theory is a linear combination of the constraints. The meaning of these constraints is discussed in terms of the generators of the invariance group of the theory. (Dissertation Abstr.)

18874 ASYMPTOTIC EFFECTS OF INCOMING GRAVITATIONAL RADIATION. Couch, Walter Eugene. Pittsburgh, Univ. of Pittsburgh, 1966. 85p.

Thesis.

A method is provided for obtaining mixed gravitational radiation fields in asymptotic approximation in general relativity. A form of the initial value problem is given which enables one to give data that would in linear theory determine a field corresponding to pure outgoing radiation, pure incoming radiation, or a mixture of both. Solutions in asymptotic approximation have been found and studied in two particular cases. The first in its lower asymptotic orders is a linear incoming quadrupole field, and initial data may be chosen such that the full solution is the linear incoming quadrupole field on one null surface. The second in its lower orders corresponds to an incoming quadrupole field plus an outgoing quadrupole field plus a mass monopole field; and again the initial data may be chosen so that the solution is the linear ope on one null surface. A calculation is performed in second-order perturbation theory that indicates the presence of backscattering in a solution which is taken initially to be a linear outgoing quadrupole. The backscattered radiation has the angular dependence of a quadrupole and a 16-pole field. (Dissertation Abstr.)

18875 CLASSICAL MECHANICS, QUANTUM MECHANICS, FIELD THEORY. Katz, Amnon. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 22. New York, Academic Press, 1965. 215p. $7.50.

Four chapters discuss many aspects of classical physics, quantum mechanics, many identical particles, and relativistic theory. (M.O.W.)

18876 PRINCIPLES OF RELATIVITY PHYSICS. Anderson, James L. New York, Academic Press, 1967. 496p. $14.75.

A graduate text is presented which provides a contemporary account of the work being done in the field of relativity theory, with an emphasis on the pertinent relationship between relativity and current research in physics. An expanded treatment of the relativistic system of particles is given and attention is directed to symmetry concepts as they play a major role in modern physical thought. The results of a study of the basic principles underlying all physical theories that make use of the space–time concept are incorporated. (W.D.M.)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 18476, 19165, 19170, 19173, and 19296.

Electromagnetic

18877 (AED-C-23-10) HIGH ENERGY PHYSICS INDEX. Volume 5, 1967. Numbers 1–2 (1-762). (Zentralstelle fuer Atomkernenergie-Dokumentation, Frankfurt am Main (West Germany)). Feb. 1967. 270p. Dep. mn.

Included in experimental physics in the high energy physics index are weak, strong, and electromagnetic interactions, strange particles, accelerators, and methods and instruments. The theoretical physics covered includes strong, weak, and electromagnetic interactions, strange particles, symmetry principles, and field theory. Author, report number, and subject indices are given. (J.F.P.)

18878 (DESY-67/3) π^+ PHOTOPRODUCTION BETWEEN 1.2 AND 3 GeV AT VERY SMALL ANGLES. Buschhorn, G.; Carroll, J.; Eandi, R. D.; Heide, P.; Huebner, R.; Kern, W.; Koetz, U.; Schmueser, P.; Skronn, H. J. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany). Hamburg Univ. (West Germany). II. Institut fuer Experimentalphysik). Feb. 1967. 9p. Dep. mn.

The reaction $\gamma p \rightarrow \pi^+ n$ was investigated for photon energies between 1.2 and 3 GeV and pion cm angles from 2.5 to 15°. The cross section is strongly peaked in the forward direction and shows resonance structure in the region of the $N^*_{\frac{5}{2}}$(1920) and $N^*_{\frac{9}{2}}$(2190). (auth)

18879 (JINR-P1-3143) ISSLEDOVANIE OBRAZOVANIYA (e^+e^-)-PAR ELEKTRONAMI S ENERGIEI 2.4 GeV. (Investigation of (e^+e^-) Pair Production by Electrons With Energy of 2.4 GeV). Bem, Ya.; Grishin, V. G.; Muminov, M. M.; Ryabtsov, V. D. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 26p. (In Russian). Dep. mn.

Direct production of (e^+e^-)-pairs with E $\gamma \geq$ 10 MeV by 1.25-4 GeV electrons was investigated with the help of a 24-liter propane bubble chamber. The obtained cross section $\sigma_{tr} = 55 \pm 24$ mb is in agreement with the theoretical value obtained by Bhabha. The method proposed admits a successful measuring of the σ_{tr} by means of a hydrogen bubble chamber. (auth)

18880 ELECTRON SCATTERING FROM THE DEUTERON AT $\theta = 180°$. Rand, R. E.; Frosch, R. F.; Littig, C. E.; Yearian, M. R. (Stanford Univ., Calif.). Phys. Rev. Lett., 18: 469-72(Mar. 20, 1967).

Cross sections for elastic and inelastic electron scattering from the deuteron at a scattering angle of 180° and incident electron energies up to 370 MeV were measured. The elastic scattering results agree with previous results and disagree with simple impulse-approximation theory. A similar effect is demonstrated in the inelastic scattering. At a scattering angle of 180° the inelastic cross section near threshold is dominated by the M1 transition from the ground to the virtual ^1S state of the deuteron. At high electron energies the experimental values of the inelastic cross section near threshold are appreciably larger than the values derived from impulse-approximation theory. (J.F.P.)

18881 π^+ PHOTOPRODUCTION BETWEEN 1.2 AND 3 GeV AT VERY SMALL ANGLES. Buschhorn, G.; Carroll, J.; Eandi, R. D.; Heide, P.; Huebner, R.; Kern, W.; Koetz, U.; Schmueser, P.; Skronn, H. J. (Deutsches Elektronen-Synchrotron, Hamburg, Univ., Hamburg). Phys. Rev. Lett., 18: 571-4(Apr. 3, 1967).

The reaction $\gamma + p \rightarrow \pi^+ + n$ was investigated for photon energies between 1.2 and 3 GeV and pion cm angles from 2.5 to 15°. The cross section is strongly peaked in the forward direction and shows resonance structure in the region of the $N^*_{\frac{5}{2}}$(1920) and $N^*_{\frac{9}{2}}$(2190). (auth)

18882 MEASUREMENT OF THE γ NN* FORM FACTOR. Ash, W. W.; Berkelman, K.; Lichtenstein, C. A.; Ramanauskas, A.; Siemann, R. H. (Cornell Univ., Ithaca, N. Y.). Phys. Lett., 24B: 165-8(Feb. 6, 1967).

The cross section for $e^- + p \rightarrow e^- + N^*$ (1230) is measured by observing inelastically scattered electrons in coincidence with protons from $N^* \rightarrow p + \pi^0$. It is found that $G^*_M(k^2)$, the magnetic dipole γNN* form factor, is proportional to $G_{MV}(k^2)$ and extrapolates to the photoproduction value at $k^2 = 0$. (auth)

18883 DOPPLER BROADENING OF ANNIHILATION RADIATION. Murray, G. (Univ. of Manchester, Eng.). Phys. Lett., 24B: 268-9(Mar. 20, 1967).

The Doppler broadening of annihilation radiation was observed using a Ge(Li) detector. It is pointed out that detailed information on the motion of the annihilating positron-electron pairs may readily be obtained using such detectors. (auth)

18884 PHOTOPRODUCTION OF π^0 FROM HYDROGEN NEAR THE SECOND AND THIRD PION-NUCLEON RESONANCES. Ward, Calvin Bruce. Los Angeles, Univ. of California, 1966. 114p.

Thesis.

Measurements of the differential cross section for the process $\gamma + p \rightarrow \pi^0 + p$ were made at eight pion center-of-mass angles in the range 51 to 135° and for incident laboratory photon energies of approximately 600 to 1200 MeV. The bremsstrahlung photon beam used was obtained from the California Institute of Technology Electron Synchrotron. Both the recoil proton and one gamma-ray from the decay of the π^0 were detected. The incident photon energy was determined by measuring the laboratory angle and time-of-flight of the recoil proton. The angular distributions obtained were consistent with those expected from a combination of multipoles with no important contribution from vector meson exchange processes. The simplest interpretation of the angular distributions obtained in the region of the third pion-nucleon resonance required that both the magnetic quadrupole and the magnetic octopole transition amplitudes be resonant at the third pion-nucleon resonance. This result is in agreement with the results of the phase-shift analysis of pion nucleon elastic scattering which indicate that the third pion-nucleon resonance is in fact the superposition of a $D(\frac{5}{2})$ and an $F(\frac{5}{2})$ resonance, both of which have the same width and mass. (Dissertation Abstr.)

18885 THE ELASTIC SCATTERING OF HIGH ENERGY ELECTRONS FROM PROTONS AT 180°. Gram, Peter Andreas Munch. Stanford, Calif., Stanford Univ., 1966. 111p.

Thesis.

High energy electrons exist in states of well defined helicity. Therefore, when an electron is scattered through an angle of 180°, it is influenced only by the magnetic moment of the scatterer. Thus, at 180°, the electron-proton scattering cross section depends only upon the magnetic form factor G_M. A new experimental technique is described which made possible the measurement of independent absolute values of the electron-proton scattering cross section in the previously unexplored region of scattering angles greater than 145°. Instead of counting the scattered electrons, the high momentum protons recoiling in the forward direction are counted. A large magnetic spectrometer is used to focus and to define the momentum and scattered angle of the protons. At 0° scattered proton angle, the same magnet serves to ditch the electron beam as well. A counter telescope coupled to a fast electronic logic system was used to make positive identification of all particles transmitted by the spectrometer. Absolute values of the scattering cross section were determined at values of the momentum transfer squared, (q^2), between 5 F^{-2} and 20 F^{-2}, and in the range of scattered electron angles between 128° and 180°. The experiment was programed to determine sets of cross sections at constant values of q^2 but different values of the scattering angle. Holding q^2 constant while allowing the scattering angle to vary casts the theoretical expression for the first order cross section, the Rosenbluth formula, into a particularly tractable form for the accurate extraction from the data, by statistical methods, of the proton form factors. (The form factors are functions of q^2 only.) These data were tested for a possible significant contribution to the scattering cross section at large angles arising from two photon exchange processes. Within the accuracy achieved in this measurement, on the average ±5%, no breakdown of the Rosenbluth formula could be detected. This result is in agreement with theoretical expectation and with other experimental findings as well. The experiment has, therefore, yielded an accurate set of values of the proton's magnetic form factor, G_M. The values for G_M tend to be a few percent smaller than those reported in other measurements in the region of q^2 above 14 to 16 F^{-2}; below this value of q^2 the agreement with other results is very good. The experimental technique which was established should be useful in other studies of electron scattering processes in which it is useful to isolate magnetic interactions from electric ones. (Dissertation Abstr.)

Weak

18886 (NEVIS-160) A TEST OF THE $\Delta S = \Delta Q$ AND $|\Delta I| = 1/2$ RULES AND CP INVARIANCE IN K^0 DECAY. Schmidt, Peter (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). Feb.

1967. Contract AT(30-1)-1932. 77p. (CU-1932-264; R-581). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Several neutral K properties were investigated with K^0 and $\bar{K}^0$ produced by stopping antiprotons in a hydrogen bubble chamber. A total of 735,000 annihilations yielded about 10,000 neutral K decays into charged particles. No disagreement with the $\Delta S = \Delta Q$ rule, the $|\Delta I| = \frac{1}{2}$ rules, and CP invariance was found. The decay rates for $K_2 \rightarrow \pi^+\pi^-\pi^0$ and $K_2 \rightarrow \pi l \nu$ were measured as being $(1.4 \pm 0.4) \times 10^6$ sec^{-1} and $(9.85 \pm 1.1) \times 10^6$ sec^{-1}, respectively. (auth)

18887 METHOD OF MEASURING THE HELICITY OF THE ANTINEUTRINO. Palathingal, J. C. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 18: 473-4(Mar. 20, 1967). (COO-1112-52).

It is shown that the need for a coincidence arrangement, which is the most serious difficulty in a measurement of the antineutrino helicity, may be eliminated. This would also allow the use of a gaseous source, which is quite inconvenient in a coincidence experiment. (J.F.P.)

18888 MEASUREMENT OF THE K^+_{e2} BRANCHING RATIO. Bowen, D. R. (Univ. of Pennsylvania, Philadelphia); Mann, A. K.; McFarlane, W. K.; Franklin, A. D.; Hughes, E. B.; Imlay, R. L.; O'Neill, G. K.; Reading, D. H. Contract AT(11-1)-2171. Phys. Rev., 154: 1314-22(Feb. 25, 1967). (NYO-2171-212).

The K^+_{e2} branching ratio was measured in a spark-chamber and counter experiment at the Princeton-Pennsylvania accelerator. A K^+ beam which yielded an average of 500 stopped, identified K^+ mesons per second was used. Particles which left the stopping region approximately at right angles to the incident beam passed through a series of six thin-plate chambers situated in a 7.5-kG magnetic field which permitted measurement of the particle momentum with a standard deviation of 1.9%. Positrons were identified by a threshold gas Cerenkov counter placed behind the magnetic field. A thick-plate spark chamber was placed behind the Cerenkov counter to permit observation of a particle emerging from that counter and measurement of the particle's total range The time interval between the K^+ stop and decay was recorded for each event. Discrimination against background events, arising principally from the $K^+_{\mu 2}$ decay mode, was provided by selection criteria on momentum, range, the time between the K^+ stop and decay, and by a requirement that the measured position of the track at the entrance to the thick-plate chamber match the extrapolated momentum chamber track. After applying these criteria, we obtain a total of seven events in the momentum interval 242-252 MeV/c in which positrons from K^+_{e2} should fall, with 2.8 of these events estimated to be background. This gives a K^+_{e2} branching ratio of $(2.1^{+}_{-}{}^{1.2}_{0.8}) \times 10^{-5}$, in agreement with the prediction of V-A theory, which, including a radiative correction, is 1.44×10^{-5}. (auth)

18889 EXPERIMENTAL PROPERTIES OF THE $\pi^+\pi^-$ CP-VIOLATING DECAY OF THE LONG-LIVED NEUTRAL K-MESON. Vernon, Carl Wayne. Princeton, N. J., Princeton, Univ., 1966. 86p.

Thesis

An experiment which confirms the existence of the $K^0_L \rightarrow \pi^+ + \pi^-$ decay was completed. That part of the data relating to the branching ratio of this CP-violating decay mode to all charged modes is presented. Decays were observed with a spark chamber-magnet spectrometer in the momentum interval 0.8 to 2.8 BeV/c, and it was found that E^n_K for an assumed energy dependence of the branching ratio yielded $n = 0.03 \pm 0.33$. There is no possibility that an E^2_K dependent branching ratio can completely explain the observed effect. This is also good evidence against some particle X with a lifetime considerably different than the K^0_L lifetime being responsible for the decay. The ratio of the X decay rate to the K^0_L decay rate is 0.95 ± 0.45 assuming the production spectra of X and K^0_L have the same energy dependence. The properties of this decay mode were compared to those of $K^0_S \rightarrow \pi^+ + \pi^-$ (coherently regenerated) and found to agree in all the tests performed. The masses are the same to 0.3 MeV, and the decay particles behave like pions in a massive range chamber. The value for the branching ratio of the $K^0_L \rightarrow \pi^+ + \pi^-$ mode relative to all charged modes is $1.97 \pm 0.16 \times 10^{-3}$. (Dissertation Abstr.)

18890 MEASUREMENT OF THE μ^+ SPECTRUM FROM $K^+_{\mu 3}$ DECAY. Hantman, Ronald David. Madison, Wis., Univ. of Wisconsin, 1965. 77p.

Thesis.

A measurement of the μ^+ spectrum from $K^+_{\mu 3}$ decay was made for the interval between 145.4 to 200.1 MeV total energy using K^+ mesons stopped in a freon bubble chamber. The observed spectrum was corrected for backgrounds and geometrical biases. The final experimental spectrum was then compared to the theoretical expressions assuming energy independence of the form factors. However, time reversal invariance was not assumed. It was found that pure scalar coupling and pure tensor coupling are very unlikely compared to pure vector coupling. Numerical values for $\mathrm{Re}(\xi)$ and $\mathrm{Im}(\xi)$, where ξ is the ratio of the vector form factors, were also found. These are $\mathrm{Re}(\xi) = -.01^{+2}_{-1}{}^{+3}_{-3}$ and $\mathrm{Im}(\xi) = 0.0 \pm 1.85$. (Dissertation Abstr.)

18891 AN EXPERIMENTAL STUDY OF THE $\pi^+ + p \rightarrow \Sigma^+ + K^+$ REACTION AT 1111, 1206, AND 1265 MeV/c. Carayannopoulos, Nicolas L. Lafayette, Ind., Purdue Univ., 1965. 96p.

Thesis.

An experimental study of the production and decay properties of the hyperon (Σ^+) produced from the reaction $\pi^+ + p \rightarrow \Sigma^+ + K^+$ at incident meson (π^+) momenta of 1111, 1206, and 1265 MeV/c is presented. An analysis of 896 events is given including an estimation of the hyperon (Σ^+) mean lifetime and determination of the branching ratio $\Sigma^+ \rightarrow p + \pi^0/(\Sigma^+ \rightarrow p + \pi^0) + (\Sigma^+ \rightarrow n + \pi^+)$, the cross sections which are listed, the least squares fit for the angular distributions, and the decay asymmetries. (TSS)

18892 MEAN LIFE OF THE π^0 MESON. Stamer, Peter Eric. Hoboken, N. J., Stevens Inst. of Tech., 1966. 42p.

Thesis.

An estimate of the π^0 mean lifetime was obtained from a sample of 232 $K^+_{\pi 2}$ ($K^+ \rightarrow \pi^+ + \pi^0$) decays at rest. The π^0's were detected by the Dalitz mode ($\pi^0 \rightarrow e^+ + e^- + \gamma$), and the decay distances from the K^+ ending to the π^0 decay points were measured. These events were found in an area scanning of an emulsion stack of 600-μm Ilford G5 emulsion pellicles exposed to a 300 MeV/c separated K^+ beam. The observed mean π^0 lifetime is $(1.0 \pm 0.5) \times 10^{-16}$ sec. (Dissertation Abstr.)

Strong (Baryon-Induced)

18893 (AD-635017) THE POLARIZATION PARAMETER IN ELASTIC PROTON-PROTON SCATTERING FROM .75 TO 2.84 GeV. Neal, Homer A. Jr. (Michigan Univ., Ann Arbor. Dept. of Physics). Apr. 1966. Contract Nonr-1224(23). 114p. (TR-2303106-23-T). CFSTI $3.00 cy, $0.65 mn.

A double-scattering technique was employed to measure the polarization parameter in elastic proton-proton scattering at .75, 1.03, 1.32, 1.63, 2.24, and 2.84 GeV. An external proton beam from the Brookhaven Cosmotron was focussed on a three-inch-long liquid hydrogen target and the elastic recoil and scattered protons were detected in coincidence by scintillation counters. The polarization produced in the scattering process was inferred from the azimuthal asymmetry exhibited in the scattering of the recoil beam from a carbon target. This asymmetry was measured by a set of two scintillation counter telescopes which symmetrically viewed the carbon target. The analyzing power of this arrangement was previously determined in an independent experiment employing a 40% polarized proton beam. The corrected values of the polarization parameter are exhibited as a function of the center-of-mass scattering angle for each incident beam energy. The prediction of the Regge theory that the polarization parameter in elastic proton-proton scattering is related to the total proton-proton and proton-antiproton cross sections was found to be consistent with the experimental results. (auth)

18894 (AD-642585) DEUTERON PRODUCTION IN PROTON-PROTON COLLISIONS FROM 1.5 TO 3 GeV. Pellett, David E. (Michigan Univ., Ann Arbor. Dept. of Physics). Aug. 1966. Contract Nonr-1224(23). 169p. CFSTI $3.00 cy, $0.65 mn.

The differential cross section for deuteron production in proton-proton collisions was measured for incident proton kinetic energies of 1.55, 2.5, and 2.9 GeV. Measurements were made at laboratory angles of 5.9, 11.55, 15.72 degrees, and at the two higher energies, at 20 degrees relative to the beam direction for deuteron laboratory momenta in the range 1.0-2.4 GeV/c. The center of mass differential cross section distributions obtained at the three energies of this experiment showed a general similarity to one another. The total deuteron production cross section decreased monotonically with incident proton kinetic energy. The cross section for production of deuterons associated with two or more pions had a maximum near 2 GeV. A search for pion resonances of unit isotopic spin in the mass range 400-1000 MeV through reactions of the form p + p to d + positive-x yielded evidence for rho meson production. The laboratory distributions in momentum and angle of deuterons produced in proton-proton collisions at 2.9 GeV were found to be much different from those arising from proton-beryllium and proton-platinum collisions at the same energy (auth)

18895 (JINR-P1-3145) NEUPRUGIE np VZAIMODEISTVIYA PRI ENERGII OT 2 DO 10 GeV. II. METODY RAZDELENIYA KANALOV REAKTSII. (Inelastic np-Interactions at 2 to 10 GeV. II. Methods of Separation of the Reaction Channels). Moroz, V. I.; Nikitin, A. V.; Rodionov, A. I.; Troyan, Yu. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 17p. (In Russian). Dep. mn.

The methods of separation of the reaction channels of np-interactions in three- and five-prong stars, produced by bombarding a 24-liter bubble chamber with 2–10 GeV neutrons, are considered. For this separation the χ^2 method was applied as well as the investigations of an extreme kinematics using some considerations on probability of realization of effective masses of secondaries. As a result a sufficiently well-defined separation of the reaction channels is obtained for the given neutron bombardment. The methods proposed allow one to estimate the most probable neutron momentum, which induced the given interaction. (auth)

18896 (JINR-P1-3167) IZMERENIE PARAMETRA R I FAZOVYI ANALIZ p-p RASSEYANIYA PRI 600 MeV. (Measurement of the R Parameter and the Phase-Shift Analysis of pp-Scattering at 600 MeV). Golovin, B. M.; Zul'karneev, R. Ya.; Kiselev, V. S.; Medved, S. V.; Nikanorov, V. I.; Pisarev, A. F.; Semashko, G. L. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1967. 10p. (In Russian). Dep. mn.

The triple scattering parameter R was measured in the scattering of 605-MeV protons on protons with spark chambers controlled by scintillation counters. The phase-shift analysis of experimental data was performed at ~600 MeV. (auth)

18897 (JINR-P1-3169) POISK REZONANSOV V SISTEME DVUKH BARIONOV SS = –1 IS = 0. (A Search for Resonances in Dibaryonic System With S = –1 and S = 0). Vishnevskii, V. F.; Moroz, V. I.; Shakhbazyan, B.A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 7p. (In Russian). Dep. mn.

Preliminary results on effective mass spectrum of the ΛP system are given. The experiment was performed with the propane bubble chamber exposed to neutrons with momenta up to 11 GeV/c. Peaks at mass values of 2062, 2220, and 2573 MeV were found. (auth)

18898 (SLAC-PUB-238) THE ABSOLUTE VALUE OF $A_{xx}(90°)$ FOR PROTON-PROTON SCATTERING AT 11.4 MeV. Noyes, H. Pierre (Stanford Linear Accelerator Center, Stanford Univ., Calif.). Dec. 1966. Contract AT-(04-3)-400. 10p. (CONF-661210-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Physical Society Meeting, Stanford, Calif.

Because of the deterioration of the target under proton bombardment, Catillon, Chapellier, and Garreta normalize their measurements of the proton-proton scattering parameters $A_{yy}(90°)$ and $A_{yy}(90°)$ at 11.4, 19.15, 23.45, and 26.5 MeV to the value of $A_{xx}(90°)$ at 11.4 MeV. In order to provide an absolute normalization for these experiments, it is noted that at 90° the value of A_{xx} is related to the ratio A_{yy}/A_{xx} by the equation $1 + A_{xx} = (1 - A_{yy}/A_{xx})/[(|c|^2/|e|^2) + 1 - A_{yy}/A_{xx}]$ where c and e are two of the four triplet p-p helicity amplitudes defined by Raynal. This result is independent of the singlet amplitude, and further, the unknown ratio $|c|/|e|$ is shown to be well approximated by $(1 + r)/(1 - r)$, where r is $\frac{1}{6}$ of the ratio of L · S to tensor contributions of the ^3P phase shifts. It is known from p-p phase shift analyses at higher energy that the L · S interaction is of short range compared to the known one-pion-exchange tensor interaction, and this ratio is expected to be small. Conservative limits at this energy are set by existing p-p models fitted to the higher energy scattering, and in this way r is found to lie between 0.087 and 0.162. The corresponding uncertainty in A_{xx} is ±0.0019, which is negligible compared to the experimental uncertainty of ±0.013 in the measurement of A_{yy}/A_{xx}. It is concluded that $A_{xx}(90°) = -0.984 \pm 0.009$ at 11.4 MeV. (auth)

18899 (UCRL–17257) NUCLEON ISOBAR PRODUCTION IN PROTON–PROTON COLLISIONS FROM 3 TO 7 GeV/c. Ankenbrandt, Charles Martin (California Univ., Berkeley. Lawrence Radiation Lab.). [1966]. Contract W-7405-eng-48. 133p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

A systematic study of the reactions pp → pp and pp → pN* in the angular range from $\theta_{lab} = 10°$ to $\theta_{cm} = 90°$ at 3, 4, 5, 6, and 7 GeV/c is reported. A "missing mass" spectrometer detected protons resulting from interactions of the Bevatron external proton beam in a liquid hydrogen target. The spectrometer consisted of a series of bending and focusing magnets and a scintillator hodoscope. Peaks in the missing mass spectra occur at average N* masses of 1240 ± 6 MeV, 1508 ± 2 MeV, and 1683 ± 3 MeV with average full widths of 102 ± 4 MeV, 92 ± 3 MeV, and 110 ± 4 MeV respectively. In the missing mass region below 2400 MeV no other significant enhancements are found. Comparison of the N* production cross sections $d\sigma/dt$ near $\theta_{cm} = 90°$ with the predictions of the statistical model indicates partial success of the model. The differential cross sections at fixed energy manifest exponential dependence on $v = [-tu/(t + u)]$, a symmetric function of the Mandlestam variables t and u, which reduces to the squared transverse momentum transfer for elastic scattering. The slopes of these exponentials vary systematically with energy in a way that depends on the particular reaction under consideration; but all these slopes tend toward the same value ($v_0 \approx 0.4$ GeV^2) at the upper limit of the energy range. (auth)

18900 CHOICE OF THE PROPER SET OF NEUTRON–DEUTERON SCATTERING LENGTHS FROM EXPERIMENTS ON TRANSMISSION OF POLARIZED NEUTRONS THROUGH A POLARIZED DEUTERON TARGET. Alfimenkov, V. P.; Lushchikov, V. I.; Nikolenko, V. G.; Taran, Yu. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett., 24B: 151-3 (Feb. 6, 1967).

Up to now two alternative sets of quartet (α_4) and doublet (α_2) n-d scattering lengths are known. Measurements are reported which resolve this ambiguity and show that the correct set is that for which α_4 is larger than α_2. (auth)

18901 PRODUCTION OF $\mathcal{N}^*(1518)$ AND $\mathcal{N}^*(1688)$ ISOBARS IN $\bar{p}p$ INTERACTIONS AT 5.7 GeV/c. DETERMINATION OF THEIR WIDTHS AND DECAY BRANCHING RATIOS. Alles-Borelli, V.; French, B.; Frisk, A.; Michejda, L. (CERN, Geneva). Nuovo Cimento (10), 47A: 232-51(Jan. 21, 1967).

The nucleon isobars $\mathcal{N}^*(1518)$ and $\mathcal{N}^*(1688)$ are observed in inelastic interactions of 5.7 GeV/c antiprotons in hydrogen. The widths of both of them are found to be small ((55 ± 15) and (70 ± 20) MeV respectively), in agreement with recent phase-shift data. The 2-body to 3-body branching ratios are estimated (being $1.25^{+0.44}_{-0.31}$ in the case of the $\mathcal{N}^*(1518)$ and less than 1.26 with 95% confidence for the $\mathcal{N}^*(1688)$) and show that the inelasticities of both resonances in π^-p scattering are high. A detailed study of the 3-body $\mathcal{N}\pi\pi$ decays provides no evidence in either case for the cascade decay into $\mathcal{N}^*(1238) + \pi$. Deviations from uniform population of the Dalitz plots for the 3-body decays are observed and are studied in terms of the 3-body decay matrix elements. Upper limits for decay of the $\mathcal{N}^*(1688)$ into $\mathcal{N}\eta$ and ΛK final states are estimated. (auth)

18902 POSSIBILITY OF INVESTIGATING THE pp INTERACTION IN THE ENERGY INTERVAL 30 TO 700 GeV. Lyubimov, V. A. JETP Lett. (USSR) (Engl. Transl.), 5: 101-4(Feb. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 125-8(Feb. 15, 1967).

The possibility of investigating elastic pp interactions in the energy range from 30 to 700 GeV using primary cosmic protons is considered. The basic idea of the experiment, the experimental setup for the investigation of pp interactions at 20 to 700 GeV, and the investigation of elastic pp scattering are discussed. (J.F.P.)

18903 EVIDENCE FOR THE EXISTENCE OF MESONS DECAYING TO FOUR PIONS. Danysz, J. A. (CERN, Geneva); French, B. R.; Kinson, J. B.; Simak, V.; Clayton, J.; Mason, P.; Muirhead, H.; Renton, P. Phys. Lett., 24B: 309-10(Mar. 20, 1967).

Evidence is presented for the production in antiproton-proton annihilations of mesons with masses (1717 ± 7) MeV and (1832 ± 6) MeV with narrow widths decaying to four charged pions in a neutral mode. (auth)

18904 PROTON–PROTON INTERACTIONS AT 5.5 GeV/c. Alexander, G.; Benary, O.; Czapek, G.; Haber, B.; Kidron, N.; Reuter, B.; Shapira, A.; Simopoulou, E.; Yekutieli, G. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev., 154: 1284-1304(Feb. 25, 1967).

This report is based on about 10,500 pp collision events produced in the 81-cm Saclay hydrogen bubble chamber at CERN. Cross-section values for the different identified final states and resonances are given. The isobars N^*_{1238}, N^*_{1420}, N^*_{1518}, N^*_{1688}, N^*_{1920}, and N^*_{2360} were identified and their production cross-section values were found via a best-fit analysis of different invariant-mass histograms. About 70% of the isobars are connected with the quasi-two-body reactions pp → N*N and pp → N*N*. The reaction pp → $nN^*_{1238}(p\pi^+)$ with a cross section of 3.25 ± 0.16 mb was analyzed in terms of a peripheral absorption model, which was found to be good agreement with the data. Various decay modes of the N^*_{1518} and N^*_{1688} isobars were observed and their branching ratios determined. The branching ratio of $n\pi^+$ to $p\pi^+\pi^-$ was found to be 0.77 ± 0.45 for N^*_{1518} and 0.67 ± 0.40 for N^*_{1688}. The branching ratio of N^*_{1238} $(p\pi^+)\pi^-$ to $p\pi^+\pi^-$ of N^*_{1688} was estimated to be 0.74 ± 0.14. Pion production turned out to be mainly due to decay of isobars. Production of meson resonances turned out to be less important; the reaction pp → $pp\omega^0$ → $pp\pi^+\pi^-\pi^0$ was identified with a cross-section value of 0.11 ± 0.02 mb. Finally, the production of neutral strange particles with a cross section of 0.45 ± 0.04 mb is discussed. Strong formation of Y^*_{1385} is observed. (auth)

18905 DOUBLE PION PRODUCTION WITHOUT ANNIHILATION IN ANTIPROTON–PROTON INTERACTIONS AT 2.7 GeV/c. Crawley, H. B.; Leacock, R. A.; Kernan, W. J. (Ames Lab., Iowa). Phys. Rev., 154: 1264-72(Feb. 25, 1967). (IS–1417).

A study was made of the reaction $\bar{p}p \rightarrow \bar{p}p\pi^+\pi^-$ at 2.7 BeV/c. The

total cross section for this reaction was determined to be 1.93 ± 0.16 mb. The data were found to be consistent with 100% $N^*\bar{N}^*$ formation, where N^* is the 1238-MeV pion-nucleon resonance with $T = T_Z = J = 3/2$. It was observed that the N^* production is highly peripheral; specifically, 50% of the $\bar{N}^*$'s are formed with $\cos\theta_{\bar{p}} > 0.8$, where $\theta_{\bar{p}}$ is the angle between the outgoing $\bar{N}^*$ and incoming $\bar{p}$ momenta in the over-all center-of-mass system. A comparison of the data with predictions of the form-factor and absorption one-pion-exchange models was made. (auth)

18906 SEARCH FOR A B = 2, S = −1 RESONANCE. Hogan, William John. Princeton, N. J.; Princeton Univ., 1966. 164p. Thesis.

The differential cross sections ($d^3\sigma/dpd\Omega$) for the production of K^+ mesons in p-p interactions were measured at laboratory angles of 20°, 30°, and 40° and at incident proton energies of 2.54, 2.88, and 3.03 GeV. A liquid hydrogen target located inside the vacuum chamber of the Princeton-Pennsylvania Accelerator was used. K^+ mesons were identified by mass analysis, using magnetic deflection and time-of-flight techniques. The time-of-flight measurements were made between two scintillation counters and also between one of them and the target. For the latter measurement the RF structure of the PPA's internal proton beam was used. The protor beam striking the hydrogen was continuously monitored with a counter arrangement located in a momentum analyzed beam at 60° and tuned for the elastically scattered protons at that angle. There appears to be no detectable center of mass angular dependence at either 2.54 or 2.88 GeV. It is found that at 2.54 GeV the data can be described very well by phase space (60% KΣN, 40% KΛN). However, the spectra obtained at 2.88 and 3.03 GeV confirm an earlier finding that there is a definite disagreement with phase space at these energies. The data are compared to three models: 1. A model based on the assumption that K^+'s are produced in the reaction $p + p \rightarrow K^+ + X^+$, where X^+ is a B = 2, S = −1 resonance which can decay into p + Λ. 2. The one-pion-exchange model. 3. The isobar model. Some portions of the data could be fitted with each model. However, none of them represents a good interpretation of the detailed experimental observations. The existence or non-existence of a B = 2, S = −1 resonance was not conclusively demonstrated. On the other hand, it is probable that the $N^*(1688)$ isobar plays a role in K^+ production. (Dissertation Abstr.)

Strong (Meson-Induced)

18907 (JINR-P13-3132) IZMERENIE π^--p RASSEYANIYA VBLIZI 180° V PUCHKE π^--MEZONOV S IMPUL'SAMI 4−7 GeV/c. (Measurement of π^-p-Scattering Near 180° in the 4−7 GeV/c π^--Beam). Kulakov, B. A.; Mal'tsev, E. I.; Filippov, P. I.; Tsislyak, O. N.; Tsyganov, E. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 16p. (In Russian). Dep. mn.

The results are given of the scattering cross section measurement near 180° using the filmless spark chamber technique. The following cross section values for the π^--meson momenta in the range of 4−7 GeV/c are obtained: for 4.0, 5.0, 6.0, and 7.0 GeV/c the cross sections 14.9 ± 1.6, 4.1 ± 1.0, 4.6 ± 1.2 and 4.6 ± 2.4 mb/sr, respectively, were found. (auth)

18908 (UCRL-11529) SOME PROPERTIES OF Ξ^- AND Ξ^0 HYPERONS PRODUCED IN K^-p INTERACTIONS BETWEEN 1.05 AND 1.7 GeV/c. Berge, J. Peter; Eberhard, Philippe; Hubbard, J. Richard; Merrill, Deane W.; Shafer, Janice B.; Solmitz, Frank T.; Stevenson, M. Lynn (California Univ., Berkeley. Lawrence Radiation Lab.). Sept. 3, 1965. Contract W-7405-eng-48. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The production of cascade hyperons by incident K^- on hydrogen was studied from threshold (1.05 BeV/c) to 1.7 BeV/c. A sample of 1004 Ξ^- and 206 Ξ^0 was obtained. Production cross sections rise over this momentum range, reaching about 150 μb for Ξ^-K^+ production and about 100 μb each for Ξ^0K^0 and $\Xi\pi K$. Production of the $\Xi^*(1530)$ near threshold is observed, and the assignment $I = 1/2$ for this resonance is confirmed. The Ξ decay analysis yields weak evidence for $J_\Xi = 1/2$. For $J_\Xi = 1/2$, the decay-parameter results are $\alpha_{\Xi^-} = -0.368 \pm 0.057$ and $\Phi_{\Xi^-} = \tan^{-1}(\beta/\gamma)_\Xi = 0.008 \pm 0.186$ radians. The final-state πΛ phase difference is then $(\delta_P - \delta_S) = \tan^{-1}(\beta/\alpha)_\Xi = -1 \pm 26°$. No significant violation of the $\Delta I = 1/2$ rule was observed. The upper limit on the leptonic decay rate. $(\Xi^- \rightarrow \Lambda\, e^-\, \nu^-)/(\Xi^- \rightarrow \Lambda\, \pi^-)$, was found to be 0.5%. (auth)

18909 (UCRL-16451(Rev.)) SPIN-PARITY DETERMINATION OF THE $Y_1^*(1765)$. Bell, Robert B.; Birge, Robert W.; Pan, Yu-Li; Pu, Robert T. (California Univ., Berkeley. Lawrence Radiation Lab.). Dec. 1, 1965. Contract W-7405-eng-48. 16p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A study based on 2100 events which fit the hypothesis $K^- + n \rightarrow \Sigma^- + \pi^+ + \pi^-$ shows that the Y_1^* (1765) exists and that the conjectured spin−parity assignment, $5/2^-$ is correct. The incident meson (K^-) momenta were 828, 930, 1025, and 1112 MeV/c which neglecting Fermi momentum, corresponds to a K^-−N cm energy of 1700 to 1845 MeV. The data were obtained from a deuterium-filled bubble chamber. The Y_1^* (1765) was found to have a mass of 1760 ± 10 MeV and a width of 60 MeV. (J.F.P.)

18910 NEGATIVE PION–PROTON ELASTIC SCATTERING AT 1.7 GeV/C. Allen, D. D.; Fisher, G. P.; Godden, G.; Kopelman, J. B.; Marshall, L.; Sears, R. (Univ. of Colorado, Boulder). pp 419-28 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

The pion-proton elastic differential cross section was studied at 1.71 GeV/c with high statistical accuracy. 3204 events were selected from a total of about 11,000 two-prong events measured and analyzed from film exposed in the 20-inch Brookhaven hydrogen bubble chamber. The shape was determined from zero to 180° pion scattering angle. The measurements show clear evidence for a second maximum in the π^-p cross section near 90° The measurements further indicate the existence of a second minimum and a peaking in the backward direction which might be the onset of a third maximum. Preliminary optical model fits to the cross section are shown for radii of 0.78 and 0.81 fermis. It is believed that both the positions and widths of the first and second diffraction maxima through the energy region 1.5 to 3.0 BeV/c can be simultaneously fitted by a phenomenological potential if a spin dependent term is incorporated. Preliminary computations using real and imaginary Yukawa potentials, including a spin orbit term, give confirmatory indications; angular momentum up to $l \leq 4$ plays a role. (L.B.S.)

18911 THREE PION PRODUCTION BY 1.95 BeV/C POSITIVE PIONS ON PROTONS. Chapman, J. W.; Fortney, L. R.; Fowler, E. C. (Duke Univ., Durham, N. C.). pp 299-316 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

The use of a new system for scanning and measuring bubble chamber film is reported, and results are presented for a study of three pion production by 1.95 GeV/c positive pions on protons. The measuring system consists of two manually operated ITEK machines operating with on-line control by a DDP-24 electronic computer. Scanning results and approximate cross sections for various channels represented in the four-pronged category are tabulated. Details are presented of the event selection and analysis, and histograms and scatter plots are shown for the particular quasi-two-body production process $\pi^+ + p \rightarrow N_{33}^* + \eta(\omega)$. (L.B.S.)

18912 DIPION EFFECTIVE MASS DISTRIBUTIONS FOR THE π^-p INTERACTION AT 8.09 GeV/C. Derado, I.; Kenney, V. P.; Poirier, J. A.; Shephard, W. D.; Synn, E. H. (Univ. of Notre Dame, Ind.). pp 317-22 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

A search for resonant states with 2π decay was made as part of a study of π^-p interactions at 8.09 GeV/c, produced in the 80-inch hydrogen bubble chamber at the Brookhaven AGS. Approximately 40,000 photographs were taken, and preliminary results on the dipion effective mass distribution obtained in data from the first half of the run are discussed. The $\pi^+\pi^-$ effective mass distribution for 707 identified events of the type $\pi^-p \rightarrow n\pi^+\pi^-$ shows that the production of the ρ^0 and f^0 is prominent. The corresponding effective mass distribution for 341 events identified as $\pi^-p \rightarrow p\pi^-\pi^0$ shows a ρ^- peak against a rapidly rising background. Some enhancement in both $\pi^-\pi^+$ and $\pi^-\pi^0$ effective mass at ~1750 MeV is suggested. (L.B.S.)

18913 K^-p INTERACTIONS FROM 900 TO 1100 MeV/c AND THEIR BEARING ON $Y^*(1765)$ AND $Y_0^*(1815)$. Yodh, G. B. (Univ. of Maryland, College Park). pp 223-54 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

A summary is presented of the experimental data of K^--p interactions from 900 to 1100 MeV/c. The bearing of these results on the nature of the two previously reported resonances $Y_1^*(1765)$ and $Y_0^*(1815)$ is discussed. 15,000 events were measured from 180,000 bubble-chamber photographs taken at the following momenta: 900, 922, 940, 960, and 985 MeV/c, the typical number of events at a given momentum in the channels $\Lambda\pi^0$, $\bar{K}n$, and $\Lambda\pi^+\pi^-$ were of the order of 300 events each. The following reactions are discussed in detail: $K^- + p \rightarrow \bar{K}^0 + N$, $K^- + p \rightarrow \Lambda^0 + \pi^0$, and $K^- + p \rightarrow \Sigma^0 + n$. Preliminary results on the production of charged Σ hyperons are also presented. The present knowledge concerning the two reso-

nances $Y_1^*(1765)$ and $Y_0^*(1820)$ is summarized, and some further experiments are suggested. (L.B.S.)

18914 ONE-PARTICLE EXCHANGE AND BARYON RESONANCES. Leitner, Jack (Syracuse Univ., N. Y. Brookhaven National Lab., Upton, N. Y.). pp 43-69 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

The results of a study of K^-p interactions at 2.24 BeV/c are reported. Information relevant to one-particle-exchange mechanisms which appear to play a dominant role in production at this energy is summarized. Results concerning baryon resonances, which make use of the peripheral aspect of production, are presented. Finally, a detailed study is made of the $Y_1^*(1660)$. (L.B.S.)

18915 ANGULAR CORRELATIONS BETWEEN PIONS IN SIX- AND EIGHT-PRONG π-p INTERACTIONS AT 8 GeV/c. Bartke, J. (Inst. of Nuclear Research, Krakow); Czyzewski, O.; Danysz, J. A.; (and others). Phys. Lett., 24B: 163-5(Feb. 6, 1967).

The strong angular correlations between pions were observed in the eight-prong interactions of 8 GeV/c π^+ with protons. Similar effect is observed in some of the six-prong reactions. (auth)

18916 A DETERMINATION OF THE MASS OF THE Λ HYPERON. Mayeur, C. (Univ. Libre, Brussels); Tompa, E.; Wickens, J. H. Univ. Brux., Inst. Phys., Bull. No. 32, 1-5(Jan. 1967).

A determination of the hyperon (Λ) mass was made in a nuclear emulsion and is based on a sample of 200 events. Decays of the hyperons (Λ) by the charged mode were obtained by area scanning in emulsion stacks previously exposed to a meson (K^-) beam. A histogram is shown for the values obtained for the mass of the hyperon (Λ) by the kinematic analysis of 195 decays. (J.F.P.)

18917 EVIDENCE FOR N* RESONANCES OF MASSES 2080 AND 2190 MeV. Yoon, T. S. (Univ. of Toronto); Berenyi, P.; Key, A. W.; Prentice, J. D.; Steenberg, N. R.; Walker, W. D. Phys. Lett., 24B: 307-8(Mar. 20, 1967).

The spectrum of invariant mass for $p\pi^+\pi^-\pi^0$ combinations from $\pi^-p \rightarrow \pi^+\pi^-\pi^-\pi^0$, at 3 GeV/c, shows peaks at 2080 and 2190 MeV. Evidence is presented to show that the 2080 enhancement decays through the $(N^*(1236)\rho)$ channel. (auth)

18918 NEGATIVE PION–PROTON ELASTIC SCATTERING AT 2.26 GeV/c. Reynolds, B. G.; Albright, J. R.; Brucker, E. B.; Harrison, W. C.; Harms, B. C.; Kimel, J. D.; Lannutti, J. E. (Florida State Univ., Tallahassee). Phys. Lett., 24B: 311-13(Mar. 20, 1967).

The differential elastic scattering cross section was measured for 2.26 GeV/c negative pions on protons. The data were analyzed in terms of two models currently used to describe the elastic scattering process. (auth)

18919 PHASE SHIFT ANALYSIS OF K^+p ELASTIC SCATTERING AT 780 MeV/c. Focardi, S. (Univ., Bologna, Modena, Italy. Istituto Nazionale di Fisica Nucleare, Bologna); Minguzzi-Ranzi, A.; Monari, L.; Saltini, G.; Serra, P.; Filippas, T. A.; Henri, V. P. Phys. Lett., 24B: 314-17(Mar. 20, 1967).

A phase shift analysis of the K^+p elastic scattering at 780 MeV/c was performed. The experimental differential cross section is best explained by a solution with dominant s wave, negative s wave phase shift (-42.7 ± 1 deg.) and small contributions of p and d waves. (auth)

18920 BACKWARD Kp ELASTIC SCATTERING AT 3.55 GeV/c. Banaigs, J. (Dept. Saturne, Saclay, France); Berger, J.; Bonnel, C.; Duflo, J.; Goldzahl, L.; Plouin, F.; Baker, W. F.; Carlson, P. J.; Chabaud, V.; Lundby, A. Phys. Lett., 24B: 317-20(Mar. 20, 1967).

Backward elastic K^+p and K^-p scattering were measured in the angular interval $168° < \theta_{c.m.} < 177°$. It is found that $(d\sigma/d\Omega)_{K^+p\rightarrow pK^+} = 17 \pm 4$ μb/sr and $(d\sigma/d\Omega)_{K^-p\rightarrow pK^-} < 0.6$ μb/sr. K^+p elastic scattering exhibits a backward peak. (auth)

18921 POSITIVE-PION PRODUCTION IN INELASTIC π^-p INTERACTIONS BETWEEN 500 AND 1300 MeV. Giancoli, Douglas C.; Barish, Barry C.; Kaplan, Selig N.; Kurz, Richard J.; Perez-Mendez, Victor; Solomon, Julius (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 154: 1250-62(Feb. 25, 1967). (UCRL-17025).

The momentum distributions of the π^+ in the reaction $\pi^-p \rightarrow \pi^+\pi^-n$ were measured at several π^+ angles for incident π^- beam energies of 516, 550, 599, 667, and 715 MeV; π^-n mass spectra were calculated from the π^+ momentum distributions. Partial data were also obtained at higher energies. The π^- beam was obtained from the Berkeley Bevatron. The momenta of the π^+ were measured with a magnetic spectrometer consisting of a C magnet and thin-walled aluminum spark chambers to display the trajectory of the particle entering and leaving the magnet. An array of scintillation counters was used to detect the occurrence of an event. An electronic time-of-flight system was used to distinguish positive pions from protons that passed through the spectrometer. The measured spectra could not be adequately explained by any of the several models which were tried, including an isobar model, although production of the (3,3) isobar is prominent. (auth)

18922 K^-p ELASTIC SCATTERING FROM 700 TO 1400 MeV/c. Holley, W. R.; Beall, E. F.; Keefe, D.; Kerth, L. T.; Thresher, J. J.; Wang, C. L.; Wenzel, W. A. (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 154: 1273-83(Feb. 25, 1967). (UCRL-16875).

Differential cross sections for elastic K^-p scattering were measured at incident-kaon momenta from 700 to 1400 MeV/c. A total of 17,000 elastic events were observed with narrow-gap cylindrical and parallel-plate spark chambers. Least-squares fits of Legendre-polynomial power series to the differential cross sections require fifth-order terms in the region of the suggested 1765- and 1815-MeV resonances. Sixth-order coefficients are not required. The behavior of the coefficients requires a highly elastic resonance near 1815 MeV and is consistent with the existence of an additional rather inelastic resonance near 1765 MeV. The total cross section and the total elastic cross section were fitted with constant background and one or more Breit-Wigner resonance terms, and a qualitative analysis of the Legendre-polynomial coefficients was made. The data favor a $J = \frac{5}{2}$ assignment for the 1815-MeV resonance, although a very elastic $J = \frac{3}{2}$ resonance cannot be completely excluded. (auth)

18923 SIX-PRONG INTERACTIONS OF 8 GeV/c π^+ IN HYDROGEN. Bardadin-Otwinowska, M.; Danysz, M.; Hofmokl, T.; Otwinowski, S.; Piotrowska, H.; Sosnowski, R.; Szeptycka, M.; Wroblewski, A. (Univ. of Warsaw. Inst. for Nuclear Research, Warsaw). Acta Phys. Pol., 31: 431-6(Feb. 1967).

A sample of 1300 six-prong interactions produced by an 8 GeV/c meson (π^+) separated beam in a bubble chamber is analyzed. Partial cross sections for the fitted reaction channels, comparison with cross sections obtained at other energies, and production frequencies of $N^{*+++}(1238)$, ρ^0, and ω^0 resonances are given. (J.F.P.)

18924 π^+p ELASTIC SCATTERING AT 2.35 AND 2.90 BeV/c. Kramer, Paul Robert. New Brunswick, N. J., Rutgers–The State Univ., 1966. 76p.

Thesis.

π^+p elastic scatterings were studied at incident momenta of 2.35 and 2.90 BeV/c. 60,000 pictures produced by the Brookhaven National Laboratories' twenty-inch hydrogen bubble chamber exposed to the Yale-BNL separated π^+ beam were analyzed. The forward differential cross sections can be described by $d\sigma/d\Omega = A \exp(-Bt)$ where t is the square of the four momentum transfer to the proton. This experiment gave $A = 17.5 \pm 1.5$ mb/sterad, $B = 6.8 \pm 0.3$ $(BeV/c)^{-2}$ at 2.35 BeV/c, and $A = 21.0 \pm 2.0$ mb/sterad, $B = 7.3 \pm 0.3$ $(BeV/c)^{-2}$ at 2.90 BeV/c. The total elastic cross sections obtained were $\sigma_e = 9.9 \pm 0.5$ mb at 2.35 BeV/c and $\sigma_e = 8.2 \pm 0.4$ mb at 2.90 BeV/c. While the slopes of the forward peaks are comparable to other experimental results, the total elastic cross section is higher. The scattering cross section in the forward direction is larger also and in fact falls above the optical theorem limits at both momenta if the forward elastic scattering amplitude is taken to be purely imaginary. (Dissertation Abstr.)

18925 FOUR- AND FIVE-PARTICLE PRODUCTION IN 3.7 BeV/c π^-p COLLISIONS. Moebs III, William D. C. Ann Arbor, Mich., Univ. of Michigan, 1965. 137p.

Thesis.

In an exposure of the BNL 20-inch hydrogen bubble chamber to a 3.7 GeV/c π^- beam, 805, 1025, and 489 events of the reaction type: (1) $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p$, (2) $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + p + \pi^0$, and (3) $\pi^- + p \rightarrow \pi^- + \pi^- + \pi^+ + \pi^+ + n$, respectively, were observed. The two- three- and four-body mass spectra were studied in a search for short-lived resonant states involving the various particle combinations. In reaction (1) there are peaks corresponding to the ρ^0, the 1238 and 1512 MeV isobars, and the A_1 and A_2 mesons. It is found that both the ρ^0 and the 1238 MeV isobar channels can be analyzed by means of the one-pion-exchange model, and consequently, the pion-pion interaction is studied for both. Reaction (2) is found to be dominated by ρ^- and ω^0 production. It is observed that both of these mesons are produced in conjunction with nucleon isobars. The ρ^- channel furnishes examples of the higher nucleon isobars decaying into a pion and the 1238 MeV (π^+,p) resonance, which in turn breaks up into a π^+ and a p. A peak is also found in the (π^-,ω^0) mass spectrum at 1250 MeV, but serious questions are raised about its interpretation as a (π^-,ω^0) resonance. Cross sections for the three reactions and the various resonance channels are also presented. (Dissertation Abstract)

18926 MEASUREMENTS OF THE DIFFERENTIAL CROSS-SECTION AT 0^0 FOR THE REACTION $\pi^-p \rightarrow \pi^0n$. Risk, Winthrop Spiridon. Princeton, N. J., Princeton Univ., 1966. 127p.

Thesis.

Measurements were made of the differential cross section near zero degrees for the reaction $\pi^-p \rightarrow \pi^0n$. The experiment covers a range of incident π^- momentum from 575 to 2085 MeV/c and supplements previous measurements in the momenta intervals 380 to 505 and 900 to 2085 MeV/c. An extrapolation of the measurements determines values for the differential cross section at zero degrees, which can be compared with the predictions of dispersion relations. In particular, the experiment produced data in the previously unmeasured momentum interval 575 to 900 MeV/c as well as in the interval 1320 to 1680 MeV/c in which a discrepancy exists between the experimental and theoretical results. It is hoped that the greater statistical accuracy of this experiment will clarify the nature of this discrepancy. Only the results of the analysis in the interval 575 to 810 MeV/c are given, but a complete description of the experiment and analysis procedure is also presented. Results for the remaining data, which are currently being analyzed, will be presented later. The values obtained for the differential cross section at zero degrees are as follows: 575 MeV/c – 3.40 ± 0.30 Mb.; 650 Mev/c – 3.18 ± 0.34 Mb.; 757 MeV/c – 2.26 ± 0.21 Mb.; and 810 MeV/c – 1.59 ± 0.15., Mb., and are in good agreement with recent dispersion relation calculations. (Dissertation Abstract)

18927 THREE-PION PRODUCTION BY 1.95-BeV/c π^+ ON PROTONS. Chapman, John Wehrley. Durham, N. C., Duke Univ., 1966. 113p.

Thesis.

The results of a study of the reactions $\pi^+ + p \rightarrow \pi^- + \pi^+ + \pi^+ + p + \pi^0$ (1) and $\pi^+ + p \rightarrow \pi^- + \pi^+ + \pi^+ + \pi^+ + N$ (2) produced in the hydrogen bubble chamber are presented. The dominance of N^*_{33}, ω, and η resonance production in the first reaction is discussed. The cross section values for the overall reactions and for the dominant final states are presented. Emphasis is placed on the $N^*_{33}-\omega$ associated production reaction $\pi^+ + p \rightarrow N^*_{33} + \omega \rightarrow \pi^+ + \pi^- + \pi^0$, $N^*_{33} \rightarrow \pi^+ + p$. The production properties of this final state are analyzed in terms of the angular properties of both the N^*_{33} and ω decays. This analysis follows the prescription outlined by Gottfried and Jackson and results in measured values for several of the N^*_{33} and ω spin density matrix elements. The $N^*_{33}-\omega$ production is shown to represent 36% of the 2.07 ± 0.15 mb for reaction (1). The cross section for reaction (2) is given as 0.18 ± 0.02 mb and the cross section for the reaction $\pi^+ + p \rightarrow \pi^- + \pi^+ + \pi^+ + p$ is given as 3.04 ± 0.15 mb. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 18864, 18962, 18969, 18999, 19023, 19167, 19296, 19310, and 19311.

18928 (JINR-E2-3119) COMPARISON OF THE DISPERSION SUM RULES WITH THE EQUAL-TIME COMMUTATOR SUM RULES. Pisarenko, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 25p. Dep. mn.

The sum rules obtained from the one-dimensional dispersion relations are compared with the sum rules deduced in the Fubini technique from the equal-time commutator relations for photoproduction problem. In the resonance model the results are the same from these treatments and are compared with experiment. The obtained sum rules for a group of the invariant amplitudes are in agreement with experiment while these for another group are not. (auth)

18929 SUM RULES BASED ON CAUSALITY. Meyer, James W.; Suura, H. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett., 18: 479-81(Mar. 20, 1967).

It is shown that if an amplitude is causal and its Fourier transform satisfies the Dyson representation, then a physically meaningful sum rule can be derived provided it converges. (J.F.P.)

18930 SOME INTERESTING ASPECTS OF PARTICLE PHYSICS AT SUPER HIGH ENERGIES. Yuan, Luke C. L. (Brookhaven National Lab., Upton, N. Y.). Z. Naturforsch., 21a: 1744-7(1966).

A brief account is given on some specific aspects of particle physics at super high energies which are of major importance to the understanding of nature of matter with the expectation that the related experiments can be carried out when these high energies become available. The discussions include asymptotic behavior, dispersion relations, broken symmetry, heavy triplets, and intermediate bosons. (auth)

18931 LAGRANGIAN FORMALISM FOR (2J+1)-COMPONENT HIGHER SPIN THEORY. Lukierski, J. (Univ., Wroclaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 14: 697-700(1966).

Lagrangians which lead to propagators for the (2J + 1)-component formalism for fields describing a particle with arbitrary spin are introduced. (J.F.P.)

18932 RELATIVISTIC PARTICLE SPECTRA AND MASS SPLITTINGS. Mukunda, N.; Sudarshan, E. C. G.; Boehm, A. (Syracuse Univ., N. Y.). Contract AT(30-1)-3399. Phys. Lett., 24B: 301-4(Mar. 20, 1967). (NYO-3399-92).

It is shown how to do three things: to construct a relativistic Lie algebra whose irreducible representations contain infinite sequences of particles with spins and isospins which can be correlated as in the isobar spectrum of strong coupling theory; to obtain a mass spectrum for such isobars from an associative algebra structure; and to show how such an associative algebra has an underlying structure in terms of a finite-parameter Lie algebra. (auth)

18933 FINAL-STATE INTERACTIONS AND THE SIMULATION OF RESONANCES. Schmid, Christoph (California Inst. of Tech., Pasadena). Phys. Rev., 154: 1363-75(Feb. 25, 1967).

It is shown that the singularities of the triangle or rescattering diagram cannot produce peaks in the total transition rate. Rescattering bands can be seen on the Dalitz plot, but their projections into invariant-mass plots do not produce peaks, if all events on the Dalitz plot are included. In other words, the Peierls mechanism and its recent variants do not work, even if the singularity is on the physical boundary. The reason is a cancellation of the peak, which occurs when the diagram without rescattering is added coherently to the triangle diagram. It is also shown that interference of overlapping resonance bands does not produce the previously expected peaks in the total transition rate or in the two-body mass plots in three different cases. This result holds to first order in the ratio of the resonance width to the diameter of the Dalitz plot. (auth)

18934 WHAT'S HAPPENING IN PARTICLE PHYSICS. Ne'eman, Yuval. Int. Sci. Technol., No. 63, 42-9; 51(Mar. 1967).

The questions and problems that are facing the theorist in an attempt to understand the structural pattern of elementary particles are presented. The idea of particle interaction processes are coupling between currents is explained and illustrated using the Feynman diagrams for weak, electromagnetic, and strong interactions. By describing these currents with the mathematics of group theory it has been possible to devise models that display the symmetries existing in nature. The success of the eightfold way is discussed. The question of which approach—current algebra, quark, or bootstrap—will lead to the final structural theory is considered. (L.B.S.)

18935 TRANSLATIONAL INVARIANCE AND ENERGY-MOMENTUM CONSERVATION LAW FOR UNSTABLE PARTICLES. Lukierski, J. (Univ. of Wroclaw). Nuovo Cimento (10), 47A: 326-9(Jan. 21, 1967).

A formulation is introduced which leads to real values of the component of four momentum even for unstable particles. (J.F.P.)

18936 LEE MODEL WITH SEVERAL V-PARTICLES. I. N-theta SECTOR. Vaughn, M. T. (Northeastern Univ., Boston). Nuovo Cimento (10), 47A: 252-64(Jan. 21, 1967).

A generalized Lee model, with several bare V-particles $V_1, \ldots, V_n$ interacting with N + 0 via Yukawa interactions with independent cut-off functions, is solved in the N – 0 sector by explicit construction of the Fredholm determinant for the sector. The generalized Levinson theorem is derived, and the equivalence between a separable N – 0 potential and a limiting case of Yukawa coupling $V \leftrightarrow N + 0$ is established. The problem of wave function renormalization is analyzed; renormalized fields corresponding to physical particles are constructed. (auth)

18937 LECTURES IN THEORETICAL PHYSICS. VOLUME VIII B. FUNDAMENTAL PARTICLES AND HIGH ENERGY PHYSICS. Lectures Delivered at the Summer Institute for Theoretical Physics, University of Colorado, Boulder, 1965. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966. 435p. $7.00.

Twenty papers are included; separate abstracts are prepared for 17. Abstracts of three papers appeared previously in NSA as 20: 9794, 27842, and 27843. (L.B.S.)

For abstracts of individual papers see: 18910–18914, 18943, 18944, 18980, 18981, 18991–18995, 19026, 19027, and 19036.

Electromagnetic

18938 (DESY–67/1) ON THE THEORY OF PHOTO- AND ELECTROPRODUCTION OF THE N*(1236). Gutbrod, F.; Simon, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1967. 38p. Dep. mn.

Multiple dispersion relations and the Fredholm determinantal method are applied to the calculation of the transverse part of the γNN^* vertex, using relativistic kinematics. The unphysical cuts of the multipole amplitudes were approximated by the second-order and fourth-order (box) diagrams containing nucleon and pion exchange. No cut-off is necessary. The results for the magnetic dipole amplitude agree, within the theoretical errors, with those of the static theory, while the electric quadrupole turns out to be resonant too. The behavior of the transition amplitudes for large momentum transfer is discussed. (auth)

18939 (DESY–67/2) DERIVATION OF SUM RULES FOR THE ISOVECTOR NUCLEON FORM FACTOR FROM A DIVERGENCE CONDITION. Schildknecht, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jan. 1967. 10p. Dep. mn.

Sum rules for the isovector nucleon form factor are derived by starting from a divergence condition describing how conservation of the isovector-vector current of hadrons is broken by electromagnetism in lowest order. (auth)

18940 (JINR-P2-3162) SPEKTR EFFEKTIVNYKH MASS V PROIZVOL'NYKH KASKADAKH. (Effective Mass Spectrum in Arbitrary Cascades). Kopylov, G. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 29p. (In Russian). Dep. mn.

A recipe is formulated which allows the expression in quadratures of the distribution of the effective mass of any group of particles produced in an arbitrary cascade. (auth)

18941 (UR–875–189) CROSS SECTION AND FORM FACTOR OF N*(1236) PRODUCTION BY ELECTRONS. Nagashima, Y. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). Mar. 2, 1967. Contract AT(30-1)-875. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Under the assumption of the predominance of the magnetic dipole transition, the cross section of N*(1236) by electrons or muons is recalculated in a covariant way in terms of momentum transfer and the invariant mass of the N*. Using the same form factor as that of elastic e-p scattering, the agreement with the experiment in the momentum transfer region $\lesssim 1$ $(BeV/c)^2$ is quite good. (auth)

18942 ALGEBRAIC COMPUTATION OF RADIATIVE CORRECTIONS FOR ELECTRON–PROTON SCATTERING. Campbell, J. A. (Oxford Univ.). Nucl. Phys., B1: 283-300(1967).

Algebraic computer programs written largely in the language LISP were developed to derive matrix elements from arbitrary Feynman diagrams, conduct mixed integral-substitution and trace operations on long expressions containing Dirac γ matrices, and help to write programs in FORTRAN for numerical evaluation of these expressions after simplification. The programs in LISP were applied to the calculation of radiative corrections to electron-proton scattering with an accuracy that was not available in previous results. The calculation includes a contribution from the excitation of the N*(33) resonance in two-photon exchange Feynman diagrams that has involved the sorting of at least 162,000 algebraic terms by an IBM 7090 computer. (auth)

18943 ELECTROMAGNETIC FORM FACTORS FOR ARBITRARY SPIN. Theis, W. R. (Univ. of Minnesota, Minneapolis). pp 135-44 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

It is shown that a proper set of form factors for any spin can be obtained if, for analyticity considerations, a connection of the matrix element of the electromagnetic current is established with a time-ordered product of interpolating field and a covariant decomposition. A 2s + 1 component free field description is given for particles of spin s and the asymptotic condition is defined, which allow the reduction formula and covariant decomposition for the matrix elements to be given. The consequences of space inversion invariance are discussed, and an interpretation of the form factors is given for small momentum transfer. (L.B.S.)

18944 PHOTOPRODUCTION OF PIONS ON NUCLEONS. Bialkowski, Grzegorz (Inst. of Theoretical Physics, Warsaw). pp 145-56 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

The photoproduction of pions on nucleons is treated within the framework of dispersion theory. The three invariant amplitudes s,t, and u are formed for the channels $\gamma + N_1 \to \pi + N_2$, $\gamma + \bar{N}_2 \to \pi + \bar{N}_1$, and $\gamma + \pi \to N + \bar{N}$. The process is described by 12 independent scalar amplitudes denoted as $H_i^{(\alpha)}$. The analytic properties of the $H_i^{(\alpha)}$ functions are discussed. Two approaches to the dispersion theory of photoproduction process are discussed; the u = constant dispersion relations used by Chew, Goldberger, Low, and Nambu (CGLN); and the fixed-angle dispersion relations. It is shown that the latter approach avoids any contribution coming from the unphysical-angles regions. The fixed-angle approach is illustrated for the simpler case of πN scattering, and the modifications needed for the case of photoproduction are pointed out. It is concluded that good agreement can be obtained between dispersion theory and experiment for photoproduction processes if the theory is carefully treated, and that $\pi\pi\pi\gamma$ interaction is not necessarily needed to obtain such agreement. (L.B.S.)

18945 STATISTICAL PROPERTIES OF COHERENT RADIATION. Arecchi, F. T. (Laboratori CISE, Milan. Univ., Milan). Nuovo Cimento (1), 4: 756-80(1966). (In Italian).

An analysis is given of correlation experiments of first order and second order fields (amplitude interferometry and intensity interferometry, respectively). The intuitive aspects of the questions of field statistics are assembled by means of a heuristic description in purely classical terms. The principles of such a classical description are briefly justified. Some recent experiments on the distribution of photons which have permitted for the first time the measurement of the Bose-Einstein distribution and the establishment of the character of laser light are illustrated. (J.S.R.)

18946 HIGH-ENERGY TRIDENT PRODUCTION WITH DEFINITE HELICITIES. Bjorken, J. D. (Stanford Univ., Calif.); Chen, M. C. Phys. Rev., 154: 1335-7(Feb. 25, 1967).

The high-energy large-scale-angle limit of the completely differential cross section for the process $e^- + Z \to e^- + e^+ + e^- + Z$ (or for the process with all or some of the particles replaced by muons) is computed for arbitrary helicities of incident and final particles. This process is interesting as a test of electrodynamics and of the statistics of the muon. The formula is short and perhaps suitable for numerical integrations. (auth)

18947 COMPTON SCATTERING AND DETAILED BALANCE. Hiida, Kichiro (Tokyo Univ.); Ebata, Takeshi. Phys. Rev., 154: 1337-40(Feb. 25, 1967). (COO–1545-10).

Possible detection of the effects due to C and T noninvariance in proton Compton scattering is discussed. It is shown that the measurement of the recoil-proton polarization together with the measurement of the differential cross section for a polarized target can provide information about the breakdown of detailed balance. The region of the second πN resonance (1520 MeV) is shown to be most suitable for such an experiment. (auth)

18948 SUM RULES FOR PHOTOPRODUCTION WITH BOSON–FERMION COMMUTATION RELATIONS. Fenster, S.; Panchapakesan, N. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 154: 1326-30(Feb. 25, 1967). (COO–264-349; EFINS–66-90).

Sum rules applicable to the photoproduction of π and η mesons on nucleons are written down using the commutation relation for electromagnetic current density with the field of the proton. These rules relate scattering channels obtained by interchanging a boson with a fermion line, e.g., $\gamma + N \to \pi + N$ and $N + \bar{N} \to \gamma + \pi$ channels. When saturated with nucleon, N^*, S_{11}, and vector-meson poles, these rules relate photonic vertices of the vector meson to the vertices of fermions. Such relations between all boson vertices and fermion vertices are consequences of the boson-fermion commutation relations. The estimate for $\pi\omega\gamma$ coupling is in agreement with the values obtained from the partial decay width for $\omega \to \pi\gamma$. The estimate for $\eta\rho\gamma$ coupling leads via the ρ-dominance model to a value of total decay width for the η meson in agreement with other such estimates. (auth)

18949 SOME COMMENTS ON THE DECAYS OF η (550). Veltman, M.; Yellin, Joel (Brookhaven National Lab., Upton, N. Y.). Contract AT(30-2)-Gen-16. Phys. Rev., 154: 1469-74(Feb. 25, 1967). (BNL–10396).

Various decay modes of the $\eta(550)$ are discussed. The relations, through SU_3 and the Gell–Mann–Sharp–Wagner model, between the η-decay modes and the modes $\eta \to \pi\pi\gamma$, $\pi^0 \to \gamma\gamma$ are investigated, taking into account η-η^* mixing. The present experimental values for the neutral branching ratios plus the shape of the $\eta \to \pi^+\pi^-\pi^0$ Dalitz plot are shown to require a 30% $|\Delta I| = 3$ contribution to the $\eta \to 3\pi$ amplitude. The connection between a possible charge asymmetry in $\eta \to \pi^+\pi^-\pi^0$ and branching ratio $\Gamma_{\eta\to\pi^0\pi^+\pi^-}/\Gamma_{\eta}^{all}$ is investigated in the framework of a model proposed earlier by several authors. It is shown that there is no conflict between the existing data and this model. The Dalitz-plot distribution of $\eta \to \pi^+\pi^-\pi^0$ is

discussed under various assumptions about the properties of the interaction responsible for the decay. (auth)

18950 RELATIVISTIC POSITRON–ELECTRON BREMSSTRAHLUNG AT WIDE ANGLES: A NUMERICAL CALCULATION. Swanson, Stanley M. (Stanford Univ., Calif.). Phys. Rev., 154: 1601-7(Feb. 25, 1967). (SLAC-PUB-211).

The bremsstrahlung spectrum for the process $e^+ + e^- \rightarrow e^+ + e^- + \gamma$ was evaluated at photon-emission angles of roughly 30 to 120° from the incident particles in the c.m. system. The phase-space integrals of the exact, lowest-order differential cross section were evaluated numerically. A computer program was used to reduce the Dirac traces to invariants and to further simplify them until reasonably compact expressions were obtained. Numerical results for selected photon angles and energies are given for 15-BeV positrons incident upon electrons at rest in the laboratory and for 600- and 4000-MeV positrons in the c.m. system (colliding-beam experiments). It was found that certain relativistic approximations to the spectrum, which are valid for forward angles, are still fairly good at wide angles; an empirical modification to such an approximation is given which provides a useful interpolation formula for the wide-angle region. (auth)

18951 ELECTROMAGNETIC PROPERTIES OF HADRONS IN THE QUARK MODEL. Rubinstein, H. R. (Weizmann Inst. of Science, Rehovoth, Israel); Scheck, F.; Socolow, R. H. Phys. Rev., 154: 1608-16(Feb. 25, 1967).

A general review of the electromagnetic properties of the hadrons when interpreted as composite states of quarks is given. Electromagnetic mass formulas are derived using two-body forces. The one-particle contributions to the magnetic moments of the baryons and to the electromagnetic decays of the vector mesons are calculated without any assumptions about the U-spin transformation properties of the photon. The electromagnetic decays of the spin-$\frac{3}{2}$ baryons are calculated in a way analogous to the Becchi-Morpurgo calculation of the rate for $\omega \rightarrow \pi^0\gamma$. A quark model of photoproduction is presented, and its predictions are accompanied by the explicit kinematic correction factors necessary for a comparison with experiment. (auth)

18952 HIGH-MOMENTUM-TRANSFER BEHAVIOR OF THE ELECTROMAGNETIC FORM FACTOR OF THE NUCLEON. Mack, Gerhard (Princeton Univ., N. J.). Phys. Rev., 154: 1617-22(Feb. 25, 1967).

A possible mechanism for the observed rapid falloff of the electromagnetic form factor of the nucleon for large momentum transfer is outlined and a heuristic calculation is given. The conjecture is adopted that the observed falloff is a consequence of a damping via unitarity by soft-meson production processes, and that recoil effects of these soft mesons can be neglected. The consequences of these assumptions are combined with a perturbation-theoretic model calculation to all orders for the one-meson production cross section. As a result $G_{Mp}/\mu_p \approx \exp\{-A[\ln^2(-at)]\}$ is obtained for the magnetic form factor of the proton. This is in good agreement with experiment for $-t > 0.3$ (GeV/c)^2. If the analytic behavior of this function is corrected by shifting the branch point from $t = 0$ to the usual position of the lowest branch point t at $= 4M_\pi^2$, $G_{Mp}/\mu_p \approx \exp\{-A[\ln^2(-a(t-4M_\pi^2)) - \ln^2(a4M_\pi^2)]\}$. Choosing the free parameters as $A = 0.172$ and $a4M_\pi^2 = 1.65$, good agreement is obtained with experiment for all $t < 0$. A general connection between breaking of dilatation symmetry, soft-meson emission, and t dependence of the form factor is pointed out briefly. (auth)

18953 DIVERGENCE CONDITIONS AND THE EQUAL-TIME CURRENT–CURRENT COMMUTATORS. Nauenberg, M. (Univ. of California, Santa Cruz. Stanford Univ., Calif.). Contract AT(04-3)-400. Phys. Rev., 154: 1455-6(Feb. 25, 1967). (SLAC-PUB-212).

The equal-time current-current commutation relations are deduced from equations for the divergence of the currents including electromagnetic and weak interactions, and canonical assumptions for equal-time commutators of electromagnetic and of weak boson fields. (auth)

18954 DECAY MODES $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$ AND $\eta \rightarrow \pi^0\gamma\gamma$. Singer, Paul (Stanford Univ., Calif.). Phys. Rev., 154: 1592-5(Feb. 25, 1967).

Rates and photon-energy spectra for the decay modes $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$ and $\eta \rightarrow \pi^0\gamma\gamma$ are calculated with the aid of a new model. The relevance of the decay mode $\eta \rightarrow \pi^+\pi^-\pi^0\gamma$ to the possibility of C violation in electromagnetic interactions is discussed. (auth)

18955 HIGH ENERGY PAIR ANNIHILATION $e^+ + e^- \rightarrow 2\gamma$. Yushin, Yu. Ya. (Inst. of Crystallography, Moscow). Phys. Lett., 24B: 291-2(Mar. 20, 1967).

Taking into account higher radiative corrections the asymptotic expression is found for the matrix element of high energy pair annihilation in forward direction. The cross sections of annihilation with little and large momentum transfer are obtained for colliding beam experiments with detection in coincidence. (auth)

18956 SUM RULES FOR COMPTON SCATTERING. I. Gourdin, M. (Faculte des Sciences, Orsay, France). Nuovo Cimento (10), 47A: 145-77(Jan. 21, 1967).

The algebra of currents is applied to the study of photon–nucleon elastic scattering by using the techniques developed by Fubini and Adler. Sum rules for the amplitudes of isovector character are studied. (auth)

18957 SUM RULES FOR COMPTON SCATTERING. II. Gourdin, M. (Faculte des Sciences, Orsay, France). Nuovo Cimento (10), 47A: 195-213(Jan. 21, 1967).

The algebra of currents is applied to the study of Compton scattering on nucleus. The Adler method has been used to derive sum rules. (auth)

18958 T-INVARIANCE OF BOOTSTRAPPED CURRENTS. Lyth, D. H. (Univ. of Lancaster, Eng.). Nuovo Cimento (10), 47A: 323-5(Jan. 21, 1967).

The invariance properties of the analogous bootstrap theory of a general set of matrix elements of a current are analyzed. A particular conclusion is that the γNN^* vertices for all N^*'s and for real or virtual photons should be T-invariant insofar as the following conditions are satisfied: the real or virtual process $\gamma + N \rightarrow \pi + N$ over the channel of each of the N^*'s is dominated by the exchange of π, N, and the N^*'s themselves, and the bootstrap equations which would then follow are capable of yielding all the γNN^* couplings in terms of the $\gamma\pi\pi$ and γNN couplings, and also the strong interactions are T invariant and the γNN vertex conserves parity. (J.F.P.)

Weak

18959 RADIATIVE CORRECTIONS TO β-DECAY AND NUCLEON FORM FACTORS. Kaellen, G. (Univ. of Lund, Sweden). Nucl. Phys., B1: 225-63(1967).

An attempt is made to estimate the radiative corrections to the vector part of the β-interaction. As previous calculations have given a result which is logarithmically divergent, the influence of nucleon structure on the radiative corrections is particularly emphasized. It is found convenient to work in a gauge where the field operator renormalization constant for a point particle is finite. An infinite number of such gauges exists. The result obtained is independent of the particular gauge chosen within this class. Further, the formulas are not written in terms of standard Feynman diagrams but in a way where on-shell-form-factors appear more directly than would otherwise be the case. This implies the use of an approach similar to dispersion theory. An approximation scheme is introduced where the contributions of states with large masses and involving mesons of various kinds are neglected in the sum over virtual states appearing inside the dispersion integral. However, the effect of all strongly interacting particles is taken into account through their influence on various nuclear form factors. This scheme leads to a finite result in first nontrivial order for the radiative β-decay. The result obtained contains integrals over several form factors some of which are experimentally known today from electron-nucleon scattering experiments while others have so far not been measured. However, in principle, they are all observable. Assuming that these unknown form factors have the same general behavior as functions of momentum transfer as the known form factors, an estimate of the effective value of the cut-off only slightly larger than the nucleon mass is found. Further, it turns out that rather wide variations in the unknown form factors can be allowed without changing this estimate appreciably. Finally, the result obtained here is applied to some pure Fermi decays using a single-particle model of the nucleus. Numerically, the new estimates differ very little from the older estimates. Therefore, the calculation can be considered as a justification of the usual procedure to put the cut-off in the standard formula for the radiative β-decay equal to the nucleon mass. (auth)

18960 QUARK MODEL FOR PARITY VIOLATING NONLEPTONIC DECAYS. Badier, S. (Univ., Paris, Orsay, France). Phys. Lett., 24B: 157-8(Feb. 6, 1967).

A very simple model for pionic two-body hadron decays which relates S-wave hyperon amplitudes and the $K \rightarrow 2\pi$ decay is presented. If the $|\Delta I| = \frac{1}{2}$ rule holds, all these amplitudes may be computed in terms of one parameter which fits the experimental data within 25%. (auth)

18961 ALGEBRA OF CURRENTS AND VECTOR-MESON DOMINANCE OF LEPTONIC K DECAYS. Clavelli, L. J. (Univ. of Chicago). Contract AT(11-1)-264. Phys. Rev., 154: 1509-14 (Feb. 25, 1967). (COO-264-335).

The algebra of currents is applied to a simple vector-meson-

dominance model of leptonic K decays. The algebra predicts different limits for the K_{l4} current as the various pseudoscalar mesons are brought to zero four-momentum in different order. It is found that this nonlinear behavior can be reproduced by requiring gauge invariance at the vector-meson weak vertices. The model provides immediate mass-shell corrections to the predictions of the current algebra. Reasonable numerical agreement is found for all the weak form factors of mesons. (auth)

18962 COMMUTATOR ALGEBRA AND THE PCAC HYPOTHESIS. Treiman, Sam (Princeton Univ., N. J.). Comments Nucl. Particle Phys., 1: No. 1, 13-16(Jan. 1967).

Comments are made on the role played by the PCAC hypothesis in extracting physical and testable implications of Gell-Mann's current commutator conjectures. The various methods and results of Adler, Weisberg, and Weinberg's application of the PCAC hypothesis to processes involving a π meson are summarized. (L.B.S.)

18963 PHOTONEUTRINO ENERGY LOSS RATES. Petrosian, Vahe; Beaudet, Gilles; Salpeter, E. E. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 154: 1445-54(Feb. 25, 1967).

The neutrino energy loss rate due to the photoneutrino process in a hot plasma, including the contribution from positrons present in the blackbody radiation, is considered. For a number of limiting regimes of density and temperature (depending on the degree to which the electrons are degenerate and relativistic), analytic expressions for the rate have been derived. A Monte Carlo method was used to carry out a five-dimensional integration to evaluate the energy loss rate for general values of density and temperature. Numerical results accurate to a few percent are presented, and a crude interpolation formula is given. (auth)

18964 TRIDENT PRODUCTION WITH NUCLEAR TARGETS. Henry, G. Reading (Harvard Univ., Cambridge, Mass.). Phys. Rev., 154: 1534-6(Feb. 25, 1967).

Trident production (production of a charged lepton pair by a charged lepton incident on a nuclear target) is discussed in the approximation of vanishing lepton mass. A compact formula is given for the trident differential cross section, valid for complex nuclear targets, taking into account nuclear recoil and inelasticities. The elastic, no-recoil approximation is also discussed. (auth)

18965 $K_1^0 \rightarrow K_2^0$ REGENERATION ON HYDROGEN. Lusignoli, M. (Univ., Rome); Restignoli, M.; Violini, G. Phys. Lett., 24B: 296-8(Mar. 20, 1967).

It is shown that dispersion relations are able to predict the hydrogen regeneration phase with very small statistical errors. Moreover this method suppresses the contribution of the unphysical and asymptotic region. (auth)

18966 ON A POSSIBLE S-MATRIX THEORY OF PHOTONS AND ELECTRONS. Haug, A. (Oslo Univ.). Phys. Norv., 1: 285-94(1961-1962).

Some remarks concerning a two-component representation of a theory of photons and electrons within the S-matrix approach to elementary particle physics are presented. Certain well-known results are derived for illustrating purposes. (auth)

18967 NEUTRINO ANNIHILATION OF ELECTRONS AND POSITRONS. Kerimov, B. K.; Dzhafarov, I. G.; Takvale, Ram; Yakh'yaev, R. Sh. Izv. Akad. Nauk Azersaidzh. SSR, Ser. Fiz.-Tekh. Mat. Nauk, No. 4, 68-73(1965). (In Russian).

The four-fermion weak interaction theory points out the possibility of direct electron-neutrino interaction, including the neutrino-annihilation of electron-positron pairs. Even though these processes have a much lower probability than the electromagnetic photon emission, at certain stages of the evolution of stars, the energy losses due to the emission of neutrino-antineutrino pairs are comparable with the energy emitted in the form of photons. In view of the large surfaces and high temperatures which prevail in stars, the electron-positron annihilation in the neutrino–antineutrino pairs $e^- + e^+ \rightarrow \nu + \bar{\nu}$ may exceed other sources of energy losses. This process was examined, taking into account the electron form factors and the spin states of all of the participating particles. The results obtained allow calculation of the form factors on the basis of the cross section of the process; the formulas derived may also be used to describe the neutrino annihilation of other fermions. (TTT)

18968 VOLUME I: ON THE RADIATIVE HYPERON DECAYS, $\Sigma^\pm \rightarrow n + \pi^\pm + \gamma$. VOLUME II: THREE-PARTICLE UNITARITY INTEGRAL. Li, Ming Chiang. College Park, Md., Univ. of Maryland, 1965. 179p.

Thesis.

VOLUME I. The observation of the $\Sigma^\pm \rightarrow n + \pi^\pm + \gamma$ radiative-decay spectra has been proposed as a method of determining the s- or p-wave nature of the Σ pionic decay. The previous theoretical treatment is based on a phenomenological interaction that neglects all form factor effects. Calculations were made to investigate the sensitivity of the theoretical predictions to structure effects using two models: (a) self-consistent pole model that includes the $\Sigma^+ \rightarrow p + \gamma$ vertex in a natural way; (b) loop model that serves as a demonstration of the radiative influence of a virtual light particle. The results show that the simple phenomenological calculation is not changed significantly. Hence, the reliability of the radiative-decay method to determine the s- or p-wave nature of Σ pionic decay is improved.

VOLUME II. The partial wave decomposition of the three-particle unitarity condition is studied. Using simple Feynman amplitude as an illustration two three-particle unitarity integrals; i.e., crossed and non-crossed integrals are constructed. The partial-wave amplitudes and their energy dependence for these two cases are investigated. It is shown that the contribution from the non-crossed integral decreases faster than that from the crossed integral as the angular momentum increases. The effects of the unstable-particle width on the effective two-particle approximation of the three-particle unitarity integral are also examined. (Dissertation Abstr.)

Strong (General)

18969 (NP-16640) THE DYNAMICS OF ELEMENTARY PARTICLES AND THE PION–NUCLEON INTERACTION. Course A. Lectures given at The Niels Bohr Institute and NORDITA Copenhagen. Hamilton, J. (Nordisk Institut for Teoretisk Atomfysik, Copenhagen (Denmark)). 1966. 239p. Dep. mn.

The discussion of the dynamical theory includes analyticity and causality for classical and elementary particle physics, and for the π–N forward scattering, and the Low relation and T-matrix. The physical applications cover the scattering of light by an atom, and meson (π)–nucleon scattering. The application of the Mandelstam representation is also given. (J.F.P.)

18970 SOME RESULTS AND PROBLEMS OF A NONRELATIVISTIC QUARK MODEL OF ELEMENTARY PARTICLES. Becchi, C.; Morpurgo, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cimento (1), 4: Suppl., 548-59 (1966).

An idea of the usefulness and difficulties of the quark model of elementary particles is considered. The topics discussed are a list of results and open problems, the Gell-Mann–Okubo mass formula for the baryons, SU(6) and magnetic moments, the vector meson radiative decays, and the absence of an E2 $N_{33}^* \rightarrow n + \gamma$ transition. (J.F.P.)

18971 UNIQUENESS OF MASS FORMULAS IN STATIC STRONG-COUPLING THEORY. Rangwala, A. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 154: 1387-98 (Feb. 25, 1967).

The question of the general mass operator satisfying the unitarity equation in the static strong-coupling theory is examined. For the symmetric scalar-meson theory, the only mass operator allowed by the unitarity equation is proportional to I^2. For the case of symmetric pseudoscalar-meson theory, the question is restricted to the two physically interesting representations only—the nucleon and the hyperon isobar series. The result in both these cases is that only the mass operator proportional to $aI^2 + bJ^2$ is consistent with the unitarity equation. (auth)

18972 QUARKS AS ADDITIVE CONSTITUENTS OF MESONS AND BARYONS. Van Hove, Leon (CERN, Geneva). Comments Nucl. Particle Phys., 1: No. 1, 8-12(Jan. 1967).

The role of quarks as additive constituents of hadrons for describing hadronic properties as well as electromagnetic and weak interactions is briefly discussed. The remarkable success of the additivity assumption for high-energy scattering, which is controlled by a strong interaction process, is noted, and this recent development of the quark model is described. (L.B.S.)

18973 REGGE-POLE DAUGHTERS AND REACTIONS INVOLVING UNEQUAL-MASS PARTICLES. Chew, Geoffrey F. (Univ. of California, Berkeley). Comments Nucl. Particle Phys., 1: No. 1, 17-19(Jan. 1967). (UCRL-17099).

The extent to which the relatively few known Regge-pole trajectories can lead to the description of high-energy hadronic interactions is considered. In particular, the question is considered that centers on the region of an unequal-mass particle, where the energy of one of the "cross reactions" passes through zero. The surprising dynamic implications which stemmed from Mandelstam's conjecture on daughter trajectories and its justification as elucidated by Freeman and Wang are discussed. (L.B.S.)

18974 DYNAMICAL THEORY OF STRONG INTERACTIONS. Susskind, Leonard (Yeshiva Univ., New York). Phys. Rev., 154: 1411-29(Feb. 25, 1967).

The many-body quantum mechanics of a set of (self-consistent) composite particles is developed for use as the basis for a theory of strong interactions. The theory deals only with physical particles which may in general have an extended spatial structure. It is a bootstrap theory in which physical particles are examined in terms of superpositions of the physical multiparticle states of the theory; no auxiliary quantities such as bare particles or fundamental local fields are introduced and no question of renormalization is encountered. Many-particle states are constructed which are (many-) three-momentum eigenstates and whose spatial integrity is assured via cluster-decomposition properties. The present theory is a dynamical theory in the sense that there is a Hamiltonian that respects the extended and composite structure of the particles and which, unlike S-matrix theory, allows a system to be studied during the course of its interactions. A drawback of the theory is that it is not manifestly Lorentz-covariant. The present paper deals with the theory in a simplified form in which heavy baryons interact with structureless mesons in the static limit of no baryon recoil. The self-consistent bootstrap dynamics is examined in the lowest order approximation, including some three-body effects. The conventional Born approximation to the scattering amplitude is recovered. The relation between the existence of particles and signs of forces is obtained. In particular the Cutkosky connection between attractive forces and group-theoretic structure is derived. (auth)

18975 CROSSING SYMMETRY AND HADRON DYNAMICS. Cutkosky, R. E. (Carnegie Inst. of Tech., Pittsburgh). Phys. Rev., 154: 1375-81(Feb. 25, 1967).

A method of carrying out bootstrap calculations is described in which analyticity properties enter indirectly. There are two main features: the use of a nonlinear Bethe-Salpeter equation which automatically maintains the symmetry properties of amplitudes, and the use of crossing symmetry in the construction of effective propagators. Two illustrative examples are considered. One is a simplified nonlinear equation for the familiar static model of baryon-meson interactions. The other is a model for interactions mediated by vector mesons. (auth)

18976 CHIRAL SYMMETRY FOR REGGE RESIDUES. Mitter, P. K.; Sawyer, R. F. (Univ. of California, Santa Barbara). Phys. Rev., 154: 1382-6(Feb. 25, 1967).

It is assumed that the octet Regge trajectories of baryon number zero belong to $(8,1) \pm (1,8)$ representations of chiral $U(3) \otimes U(3)$. The relations among residues at zero momentum transfer which follow from this assumption are studied. Predictions are made for the $^3/_2{}^+$-isobar forward-production cross section in baryon-baryon and meson-baryon scattering. The prediction (at sufficiently high energies) $(d\sigma/d\Omega)_{t=0}\ (p + p \rightarrow p + N^{*+}) = 8/9(d\sigma/d\Omega)_{t=0}\ (p + n \rightarrow n + p)$ seems to be in reasonable agreement with experiment. The $U(3) \otimes U(3)$ group is also found useful in exploring the possible dynamic origin and consequences of exchange degeneracy (degeneracy of odd- and even-signature trajectories). (auth)

18977 SATURATION OF SUM RULES IN PARTICLE REPRESENTATION OF RESONANCES. Cheng, W. K.; Kim, C. W. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 154: 1525-33 (Feb. 25, 1967).

The saturation of various sum rules of the Adler-Weisberger (AW) type for the strangeness-conserving and strangeness-nonconserving cases are investigated by including all the observed hadrons, both particles and resonances, with a mass up to about 2 BeV. General expressions for the sum rules are derived in the "particle" representation of resonances; the sum rules are given in terms of the experimentally known axial-vector weak coupling constants $G_A(\beta \rightarrow \alpha)$ and strong coupling constants $f_{\pi(K)\alpha\beta}$, using relations of the Goldberger-Treiman (GT) type. The details of numerical analyses are presented. The saturation of the AW-type sum rules can indeed be greatly improved, allowing, of course, for the relatively large uncertainties due to the GT-type relations and the presently available experimental data. (auth)

18978 MODIFIED BACKGROUND CALCULATIONS FOR HIGH-ENERGY PERIPHERAL INTERACTIONS. Maor, Uri (Harvard Univ., Cambridge, Mass.). Ann. Phys. (N. Y.), 41: 456-76(Feb. 17, 1967).

Background distributions for a final state of four or five particles are calculated for reactions in which a resonance production reduces the final state effectively to a three-body state. The failure of the phase-space distribution to account for background contributions to the reaction characterized by small momentum transfers is demonstrated. Kinematical mass enhancements arising from various one-particle-exchange mechanisms are calculated in detail, with special attention to the reported A_1 and B peaks. Possible criteria for distinguishing a kinematical mass peak from a genuine resonance are discussed, and difficulties in such an analysis are pointed out. (auth)

18979 DYNAMICS OF QUARK MODELS. Squires, Euan J.; Watson, Peter J. S. (Univ. of Durham, Eng.). Ann. Phys. (N. Y.), 41: 409-22(Feb. 17, 1967).

A dynamical calculation involving $q\bar{q}$ and $\pi\pi$ channels was performed with a view to estimating the effect of the $\pi\pi$ channel on the masses of bound states and their couplings to other particles. The internal consistency of meson couplings to quarks is also considered. The results are reasonably favorable to the idea of quark models, particularly if the quark-antiquark force has a very short range. The predictions of the short-range and long-range force models are compared. (auth)

Strong (Baryon No. = 0)

18980 REGGEIZED BOOTSTRAPS. Nath, Pran (Univ. of Pittsburgh). pp 323-33 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

A brief review is given of various attempts in the direction of Reggeized bootstraps, and the drawbacks in each of the proposals are pointed out. A bootstrap proposal is presented which is based on a recently obtained Regge-pole representation for the partial-wave S matrix. The representation gives the right threshold behavior for the real and imaginary parts of the amplitude and reproduces the proper analytic structure in the $\cos\theta$ plane for the total amplitude. Furthermore, the representation gives fast convergence both for the partial wave and total amplitude in terms of the number of trajectories. The procedure is first illustrated for the case of nonrelativistic potential scattering. An extension is then made to the relativistic case, considering elastic $\pi-\pi$ scattering for simplicity. (L.B.S.)

18981 INELASTIC UNITARITY EFFECTS ON COMPOSITE SYSTEMS. Nath, Pran (Univ. of Pittsburgh). pp 335-43 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

The coupling of a nearby inelastic channel on the dynamics of a previously uncoupled system is examined in order to obtain semi-quantitative estimates for the mass shift and change in width for a resonance induced due to the perturbing influence of such a channel. A brief discussion is given of the uncoupled-phase method, which considers the effect of introducing an extra channel n(th) on an already coupled system of (n-1) channels. The method is illustrated for the two coupled channels $\pi\pi$ and $\pi\omega$. It is found that the inelastic channel decreases the width of the single channel and also reduces the asymmetry of the resonance on the high energy and low energy side of the resonance peak. The dispersion theory approach for calculating first-order changes in masses and coupling constants in terms of the inelasticity parameter is also discussed. (L.B.S.)

18982 BOOTSTRAP STUDIES OF THE ρ MESON AND THE "GENERALIZED POTENTIAL" OF THE MODIFIED CHENG REPRESENTATION. Abbe, W. J. (Univ. of Michigan, Ann Arbor. Univ. of Georgia, Athens); Kaus, P.; Nath, P.; Srivastava, Y. N. Phys. Rev., 154: 1515-22(Feb. 25, 1967).

A bootstrap calculation for the width of the ρ resonance is performed using a simplified version of a Reggeized bootstrap theory proposed recently. A phenomenological Pomeranchuk input trajectory is assumed. The I = 2 channel is eliminated from the appropriate crossing relation and no statements about this channel are necessary. The 2-π continuum states are assumed to be dominated by the ρ for the I = 1 and by the f^0 for the I = 0. The input ρ trajectory is parameterized to produce the ρ resonance at the observed mass. The ρ width is then determined by the maximum satisfaction of the crossing relations. The calculation yields a "best" width of 125 MeV for the ρ. The problem concerning the simultaneous bootstrap of the ρ mass and width is briefly discussed, and a systematic procedure for obtaining the "generalized potential" of the modified Cheng representation is given. (auth)

18983 EFFECT OF 2^- B EXCHANGE IN THE $\pi\omega$ CHANNEL ON THE PARAMETERS OF THE ρ. Atkinson III, Reilly; Everett, Allen E. (Tufts Univ., Medford, Mass.). Phys. Rev., 154: 1430-2(Feb. 25, 1967).

The question is considered of whether the inclusion of the attractive force in the coupled $\pi\omega$ channel due to the exchange of a 2^- B particle, for which there is some theoretical and experimental evidence, might lessen the discrepancy between the calculated and experimental values of the width of the ρ meson. The procedure of Fulco, Shaw, and Wong is followed in which the matrix ND^{-1} equations are solved with a cutoff adjusted to produce the ρ at its experimental mass. We find that the resulting width is almost totally insensitive to the inclusion of the B-exchange

force. The insensitivity is due to the fact that, while the Born amplitude for B exchange is positive and of appreciable size, it decreases with energy in such a way that its contribution to the kernel of the integral equation for the N matrix is negative, and the change in the N matrix produced by B exchange is therefore suppressed. The conclusions are independent of the mass and width of the exchanged 2^- particle. (auth)

18984 PARTIAL CONSERVATION AND THE 2^+ MESONS. Krolikowski, W. (Univ. of Warsaw. Inst. for Nuclear Research, Warsaw). Phys. Lett., 24B: 305-6(Mar. 20, 1967).

A partial conservation relation involving the 2^+ mesons is conjectured. (auth)

18985 A REMARK ON PCTC, UNIVERSALITY AND GAUGE INVARIANCE. Costa, G. (Instituto de Fisica Teorica, Sao Paulo, Brazil. Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Savoy, C. A.; Zimerman, A. H. Nuovo Cimento (10), 47A: 319-22(Jan. 21, 1967).

Two applications of the algebra of tensor charges are presented: a different derivation of $f' = f$ based on the universality of the vector meson coupling, specifically $f_{\rho\pi\pi} = f_{\rho\rho\rho} = f_\rho$, and the result that the coupling constant of a direct quadrilinear coupling $f_{\rho\rho\pi\pi}(\rho_\alpha \times \pi)(\rho_\alpha \times \pi)$ is the same as required by the gauge theory of vector mesons. (J.F.P.)

18986 GEOMETRICAL RESTRICTIONS ON THE PION–PION PARTIAL WAVES. Martin, A. (CERN, Geneva). Nuovo Cimento (10), 47A: 265-81(Jan. 21, 1967).

Various rigorous inequalities on pion-pion partial waves in the interval $0 \leq s \leq 4$ are obtained from crossing symmetry and positivity properties due to unitarity. In particular, the position of the minimum of the $\pi^0\pi^0$ S-wave amplitude is located between close limits. The threshold behavior of higher waves is established, with the help of some additional assumptions. The positivity of the $T = 0, l \geq 2$ partial waves is used to prove the existence of an essential singularity at $s = 0$ on the second sheet, or more precisely, that poles accumulate at $s = 0$. (auth)

18987 CURRENT ALGEBRAS APPLIED TO MESON STATES. Segre, G. (Univ. of California, Berkeley); Walecka, J. D. Ann. Phys. (N. Y.), 40: 337-56(Dec. 1966).

The matrix elements between meson states of commutators of charges, as obtained from a quark model are considered. It is shown, employing a covariant, dispersive sum rule approach that a consistent solution to all the commutation relations is obtained by assuming that a pseudoscalar meson nonet and a vector meson nonet saturate the sum rules. Predictions of the rates of electromagnetic and strong decays of vector mesons, some of which follow from SU(3) alone, are given and comparison with experiment is made. The relation of the matrix elements of the charges with the matrix elements of the group SU(6)W is shown. (auth)

Strong (Baryon No. = 1)

18988 (AD-642374) BARYON EXCHANGE MODEL FOR XION PRODUCTION PROCESSES. James, Philip B. (Illinois Univ., Urbana. Dept. of Physics). 1966. 7p. CFSTI $3.00 cy, $0.65 mn.

Consideration is given to the clarification of the predictions of a baryon exchange model (proposed by L. Lyons) for the neutral xion production process $K^- + p$ yields $Xi^0 + K^0$. (auth)

18989 (TID-22415) PHENOMENOLOGICAL ANALYSIS OF THE REACTION $\pi + N \rightarrow \pi_1 + \pi_2 + N^1$ FROM THRESHOLD TO 700 MeV. Technical Report No. 512. Yodh, G. B. (Maryland Univ., College Park. Dept. of Physics and Astronomy). Oct. 1965. Contract AT(40-1)-2504. 51p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A phenomenological analysis of single meson (π) production from threshold to 700 MeV is described in terms of a final state interaction model. The presentation consists of a summary of the general features of the $\pi + p$ reactions, a description of the model and definition of the parameters, determination of the dominant transitions (partial waves) for the $\pi^+ + p$ reactions, and of the $T = \frac{1}{2}$ partial wave amplitudes from the $\pi^- + p$ reactions, and preliminary attempts to explain the $\pi^+\pi^-$ enhancement at high masses in terms of triangle diagrams and possible meson (σ) production. (J.F.P.)

18990 (UCRL-16475(Rev.)) DETERMINATION OF MIXING PARAMETERS OF THE K^0-$\overline{K}^0$ SYSTEM BY MEANS OF STRONG INTERACTIONS. Crawford, Frank S. Jr. (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 19, 1965. Contract W-7405-eng-48. 13p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Attention is called to a class of experiments which provides a complete determination using strong interactions only of the mixing parameters that correspond to the linear relations among $|K^0\rangle$, $|\overline{K}^0\rangle$, $|K_S\rangle$, and $|K_L\rangle$. CPT invariance is not assumed. Two specific experiments are considered in each of which a known number of mesons (K^0) of known strangeness are produced in a liquid hydrogen bubble chamber in one of the reactions, $\pi^- + p \rightarrow \Lambda + K^0$ and $K^- + p \rightarrow \overline{K}^0 + n$. The experiment in each case consists of determining the relative time dependences and the absolute counting rates for both of the secondary reactions $K^0 + p \rightarrow K^+ + n$ and $K^0 + p \rightarrow \Lambda + \pi^+$. It is shown how any of these experiments can be used to determine the mixing parameters. Also present knowledge of the mixing parameters as obtained from the weak decays is discussed. (J.F.P.)

18991 MESON RESONANCES. Leitner, Jack (Syracuse Univ., N. Y. Brookhaven National Lab., Upton, N. Y.). pp 1-23 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

Some results are discussed concerning meson resonances produced in K^-p interactions at 4.6 and 5.0 BeV/c and K^-p interactions at 2.24 BeV/c. Information is presented on a new nonstrange meson f^* of mass ~1500 MeV. The role played by the ϕ and η^*(or X^0) within SU(3) is reviewed as a preliminary step to some speculative remarks concerning the f^* within the content of SU(3). The results of improved searches for the $\eta^* \rightarrow \rho\gamma$ decay and for a new mode $\eta^* \rightarrow \pi^0 e^+ e^-$ are reported. In addition, evidence for the J^P assignment at 0^- is reviewed. Finally, evidence for the existence of the κ meson is briefly discussed. (L.B.S.)

18992 REVIEW OF RECENT WORK ON STRANGENESS ONE AND TWO RESONANCES. Walker, W. D. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. pp 25-41 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

Recent results on strangeness-one and -two boson resonances produced in K^+p interactions are reviewed. Mass distributions for various interactions are shown, and properties of these resonances are briefly discussed. (L.B.S.)

18993 MULTICHANNEL APPROACH TO HIGH ENERGY COLLISIONS. Lichtenberg, D. B. (Indiana Univ., Bloomington). pp 71-110 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

Part I describes the application of a self-consistent peripheral model with absorption to high-energy meson-nucleon collisions. The partial-wave representation is used for calculation of the scattering cross section and T matrix for a two-channel case, considering, for example the $\pi + N \rightarrow \rho + N$ interaction. Several methods are discussed by which the Born approximation may be modified to take into account the effects of absorption of the incident and final waves. Calculations were performed for the realistic ten-channel πN problem, including the effects of spin and isospin, and the results are compared with experiment. In Part II a comparison is made of the calculation of predictions of a peripheral model with the following approximation methods: Born approximation; magic formula; magic formula with partial unitarity; and the K matrix approximation. It was assumed that the exact-model calculation consisted of the solution of a Schroedinger equation with the potential matrix having a fixed set of strengths and ranges. (L.B.S.)

18994 BARYON EXCHANGE AND PRODUCTION OF $J \geq \frac{3}{2}$ BARYONS. Schlein, Peter E. (Univ. of California, Los Angeles). pp 111-33 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

A partial summary is given of several interactions which have properties probably attributable to a dominant production through a baryon-exchange process. An investigation is made of angular correlation predictions of the "unadorned" baryon-exchange model, considering those reactions which involve production of spin $\geq \frac{3}{2}$ baryons. The following reactions are studied: $K^- + p \rightarrow Y_1^{*-} + \pi^- \rightarrow \Lambda + \pi^+ + \pi^-$; $K^- + p \rightarrow Y_1^{*+} + \pi^- \rightarrow \Lambda + \pi^+ + \pi^-$; $K^- + p \rightarrow \Xi^{*-} + K^+ \rightarrow \Xi^0 + \pi^0 + K^+$; and $K^- + p \rightarrow \Xi^{*0} + K^0 \rightarrow \Xi^- + \pi^+ + K^0$. The results of the analysis of two-body Ξ^{*-} production at 1.87 GeV/c are seen to be compatible with the model. Y^{*-} production at the same energy did not appear to agree with the simple model prediction, a situation from which it was not possible to draw any strong conclusions. (L.B.S.)

18995 PHENOMENOLOGICAL ANALYSIS OF THE REACTION $\pi + N \rightarrow \pi_1 + \pi_2 + N^1$ FROM THRESHOLD TO 700 MeV. Yodh, G. B. (Univ. of Maryland, Baltimore). pp 255-97 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

A phenomenological analysis of single pion production from threshold to 700 MeV in terms of a final-state interaction model is described. The model is based on a generalization of the usual isobar model. A summary is given of the general features of the πp interactions that are studied, pointing out the variables most important to the analysis. The determination of the dominant transitions (partial waves) for the π^+p interactions and the $T = \frac{1}{2}$ partial wave amplitudes from the π^-p interactions are presented. Finally, the inadequacies of the analysis and preliminary attempts to explain the $\pi^+\pi^-$ enhancement at high masses in terms of triangle diagrams and possible σ-meson production are discussed. (L.B.S.)

18996 πN CHARGE-EXCHANGE POLARIZATION AND THE BARYON TRAJECTORIES IN THE DIRECT CHANNEL. Desai, Bipin R.; Gregorich, David T.; Ramachandran, R. (Univ. of California, Riverside). Phys. Rev. Lett., 18: 565-8(Apr. 3, 1967).

It is predicted that baryon trajectories continue to rise for quite large energies. The ρ Regge amplitude, along with the direct-channel contribution written in the Khuri representation, gives excellent fits to the polarization and the differential cross section data, even though the elasticity factors involved are quite small. At a given energy W, the direct-channel contribution is predominantly imaginary and comes mainly from partial waves in the neighborhood of $J \simeq \mathrm{Re}\alpha(W)$. (auth)

18997 LARGE-ANGLE POLARIZATION AND THE SPIN AND PARITY OF PION–NUCLEON RESONANCES. Hoff, G. T. (Univ. of Illinois, Chicago). Phys. Rev., 154: 1331-4(Feb. 25, 1967).

Simple methods are proposed for the determination of the spin and parity of resonant states above 2 BeV/c in π^+p elastic scattering and the phase and magnitude of the spin-flip and spin-nonflip background amplitudes in the large-angle region. (auth)

18998 EFFECT OF A CASTILLEJO–DALITZ–DYSON POLE IN THE πN $I = \frac{1}{2}$, $J = \frac{1}{2}^+$ AMPLITUDE. Sheth, Bidhanchandra I.; Tubis, Arnold (Purdue Univ., Lafayette, Ind.). Phys. Rev., 154: 1322-5(Feb. 25, 1967).

Recent phase-shift analyses of the $I = \frac{1}{2}$, $J = \frac{1}{2}^+$ πN amplitude imply that the real part of the phase shift changes sign at about 150-MeV pion lab kinetic energy and either passes through 90° or reaches a maximum slightly below 90° at about 600 MeV. These features of the phase shift strongly contradict the predictions of dispersion-theory calculations of the nucleon mass, which generally yield a negative phase shift decreasing with increasing energy. It is assumed that the observed phase-shift behavior is due to multichannel-coupling effects which can be accounted for in a single-channel calculation only by including a Castillejo–Dalitz–Dyson pole. A previous determination of the nucleon mass, m, and coupling with pions, $g^2/4\pi$, based on the assumed knowledge of the πN $I = \frac{1}{2}$, $J = \frac{1}{2}^+$ (N^*) resonance parameters, is repeated with the inclusion of a CDD pole. A variant of the Balázs method is used. The CDD pole parameters are determined so as to give the phase-shift behavior mentioned above. The Balázs-pole residues are determined by requiring crossing symmetry in a form relating the πN amplitude on the nearby left-hand cut to physical πN scattering. It is found that $m = 0.97$ in units of the physical nucleon mass; $g^2/4\pi = 10.5$; and a πN $I = \frac{1}{2}$, $J = \frac{1}{2}^+$ scattering length between about −0.038 and −0.048 (in units of the cube of the pion Compton wavelength), depending on the assumed energy at which the phase shift changes sign. These parameters appear to be very insensitive to the choice of Balázs-pole positions. (auth)

18999 POSSIBLE TESTS OF CURRENT ALGEBRA AND THE HYPOTHESIS OF PARTIALLY CONSERVED AXIAL-VECTOR CURRENT. Ebata, Takeshi (Ohio State Univ., Columbus). Phys. Rev., 154: 1341-4(Feb. 25, 1967). (COO-1545-6(Rev.)).

It is shown that the current algebra and the hypothesis of partially conserved axial-vector current require the existence of a certain "contact-interaction" term in the usual pseudoscalar-pseudoscalar meson theory. Possible detection of such a contact term in the reactions $\pi^+ + p \to \pi^0 + N^{*++}$ and $\gamma + p \to \pi + N^*$ is discussed. (auth)

19000 HIGH-SPIN BARYONS. II. DYNAMICAL MECHANISMS FOR REGGE RECURRENCES OF INELASTIC RESONANCES; GENERAL THEORY. Carruthers, P. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 154: 1399-1411(Feb. 25, 1967).

Virtual transitions of the type $\pi N_i \to pN_j$, where N_i represents an arbitrary nucleon isobar, are considered as the driving force for Regge recurrences of inelastic resonances. Only the s-wave pN_j configuration is considered. Since most of the low-lying isobars have even parity, the odd-parity resonances are the main concern. Regge trajectories of the latter are a consequence of Regge recurrences of the even-parity states. An important example is given by taking N_i to be the sequence: nucleon $\frac{1}{2}^+$ and its recurrence $\frac{3}{2}^+$ (quantum numbers P_{11} and F_{15} in conventional notation). Isospin and centrifugal-barrier considerations lead directly to the existence of the $D_{13}-G_{17}$ sequence. The general formalism is set up. Numerical results are given separately. First, however, a simpler derivation is given of the elastic forces due to isobar exchange in the quasistatic approximation. Previous work has shown the relation of these forces to the existence of even-parity Regge trajectories. Then the unitarity relations are set up for helicity amplitudes describing the reactions $N_a\pi \to N_c\pi$, $N_a\pi \to N_cp$, and $N_ap \to N_cp$. Next a general explicit expression is given for the one-pion-exchange (OPE) approximation for $N_a\pi \to N_cp$. Expressions are given for the above amplitudes in several models, in which only the OPE coupling is considered. The pole approximation is used to solve the many-channel N/D equations. Techniques for handling the general isospin problem are developed and their relevance to the present problem discussed. (auth)

19001 SUPERCONVERGENT DISPERSION RELATIONS AND VECTOR-MESON–BARYON COUPLINGS. Oehme, Reinhard (Univ. of Chicago). Phys. Rev., 154: 1358-62(Feb. 25, 1967). (COO-264-344).

Matrix elements of the equal-time commutators of an octet of vector current densities are considered in the infinite-momentum limit. As a consequence of locality, the Fourier transforms of these matrix elements are polynomials in the components of the momentum transfer. The resulting superconvergent sum rules are saturated with the octet and the decimet of baryons, and are evaluated at the double pole due to vector mesons. A consistent set of approximate equations for vector-meson–baryon couplings is obtained. This set has a unique nontrivial solution for the coupling constants. Together with a meson pole model for the electromagnetic form factors of baryons, these couplings give rise to relations for the form factors which are in good agreement with experiments. They are also consistent with the results obtained on the basis of collinear U(6) symmetry. (auth)

19002 CLASSICAL SCATTERING OF NEUTRAL MESONS. II. Craft, Alba D.; Havas, Peter (Lehigh Univ., Bethlehem, Pa.). Phys. Rev., 154: 1460-8(Feb. 25, 1967).

The scattering of neutral scalar and vector mesons by nucleons was previously calculated on the basis of a classical action-at-a-distance theory and compared with the corresponding field-theoretical results. In both theories the postulated vector and tensor coupling terms of the vector mesons with the nucleons were analogous to those of electrodynamics. Recently, a more general form of interaction was proposed; for monopole singularities it introduces a pseudovector coupling term which does not satisfy an equation of continuity. The scattering of neutral spin-1 mesons by heavy particles is calculated using all three coupling terms, on the basis of the field-theoretical as well as the action-at-a-distance equations of motion of the particles. Cross sections due to the pseudovector coupling alone are examined in detail. Unlike the previous results, the new field-theoretical and action-at-a-distance results show significant differences; furthermore, the behavior of the cross sections is found to depend critically on the magnitudes of the physical constants characterizing the meson field and the particles, exhibiting various resonance-like features. (auth)

19003 EQUIVALENT-POTENTIAL CALCULATION OF πN SCATTERING. Finkelstein, Jerome (Univ. of California, Berkeley). Contract W-7405-eng-48. Phys. Rev., 154: 1596-1600 (Feb. 25, 1967). (UCRL-17098).

The equivalent-potential method is extended to permit a calculation of πN states with $J = l + \frac{1}{2}$. With the potential given by nucleon and $N^*(1238)$ exchange, there are no free parameters in the calculation. The N^* is then "predicted" at a mass of 1100 MeV. The nonresonant phase shifts also agree in a general way with the results of phase-shift analysis; in particular, the S_{11} scattering length has the correct sign, while N/D calculations produce the wrong sign. It is argued that this result indicates that the force due to iteration of the potential, included in this method but not in N/D, can be important. (auth)

19004 SOME ASPECTS OF πN SCATTERING IN THE P_{11} STATE. Goldberg, Hyman (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 154: 1558-69(Feb. 25, 1967).

A study of πN scattering in the P_{11} state is presented within the framework of the unitary f matrix, or boundary-condition model. Inelastic channels treated are σN and πN^*, where σ is a $I = 0$, $J = 0^+$ $\pi\pi$ pair. The mass spread of the inelastic channel is taken into account in a unitary manner. It is apparent from an examination of the fits to the data that the σN channel is vastly preferred as an inelastic mode; the reasons are fully discussed in the text. The crossover of the phase shift at 175 MeV is seen to be impossible with a conventional force input. From a study of eigen-

phases it is concluded that there is no Breit–Wigner resonance in any eigenchannel. Also, by means of the eigenphase representation, a source of possible discrepancies in recent phase-shift analyses is demonstrated. The value of m_σ obtained for a best fit, 550 MeV, is compared with other values obtained by various authors. Finally, the effects of the P_{11} "object" on the Gell-Mann–Okubo mass formula are examined. (auth)

19005 POLARIZABILITY CONTRIBUTION TO THE HYDROGEN HYPERFINE STRUCTURE. Drell, S. D.; Sullivan, J. D. (Stanford Univ., Calif.). Phys. Rev., 154: 1477-98(Feb. 25, 1967). (SLAC-PUB-204).

At present there exists an apparent discrepancy of approximately 40 ± 20 ppm (parts per million) between experiment and theory for the ground-state hyperfine splitting in hydrogen. The proton-structure corrections which go into the theoretical hfs value is examined critically and an attempt is made to assess and improve the accuracy to which they are known. The theoretical expression for the hyperfine splitting and the corrections to it are reviewed. The origin of the proton-structure corrections is discussed along with the various physical effects: form factors, polarization, Bohr effect, etc., which have at various times been mentioned in regard to the hfs. The hfs is written down and solved for two nonrelativistic models of proton structure. The aim of these models is to provide insight into the less transparent and much less complete relativistic calculation of the structure correction. Their relation to the recent quark-model calculation of Fenster and Nambu is also discussed. The relativistic calculation of the proton-structure correction, building on the recent work of Iddings, is discussed. Calculations of the πN and πN^* intermediate states are presented. The problems of subtraction constants and contributions from high energy are taken up and the conclusions are presented. (auth)

19006 GENERALIZED WARD–TAKAHASHI IDENTITIES AND CURRENT ALGEBRAS. Raman, K.; Sudarshan, E. C. G. (Syracuse Univ., N. Y.). Phys. Rev., 154: 1499-1508(Feb. 25, 1967). (NYO-3399-66).

Generalized Ward–Takahashi identities are written for current algebras generated by conserved and partially conserved currents. The application to meson-baryon scattering is discussed and expressions for the scattering lengths are derived. An approximation is obtained for the real part of the low-energy forward meson-nucleon scattering amplitude; this gives sum rules for the low-energy phase shifts. Some questions arising from off-mass-shell extrapolations are discussed. (auth)

19007 OPTICAL-MODEL PARAMETERS AND CROSS SECTIONS FOR THE ρ-MESON–NUCLEON INTERACTION ACCORDING TO A MODIFICATION OF THE COHERENT DROPLET MODEL. Iddings, C.; Marshall, L. (Univ. of Colorado, Boulder). Phys. Rev., 154: 1522-4(Feb. 25, 1967).

A modified droplet optical-model method is developed for evaluating cross sections for short-lived ($\sim 10^{-23}$ sec) particles produced in two-body reactions. Using elastic-scattering and ρ-production differential cross sections for 1.7-BeV/c π^-p interactions in this model, the total ρ-nucleon cross section is estimated as 12 mb. (auth)

19008 POLARIZATION IN THE HIGH-ENERGY πp CHARGE-EXCHANGE SCATTERING. Bialas, E. (Jagellonian Univ., Krakow). Phys. Lett., 24B: 298-300(Mar. 20, 1967).

Phenomenological discussion of the polarization parameter P_{ex} in high-energy πp charge-exchange scattering is given following the suggestions of Bialas and Svensson. The sign and the energy dependence of P_{ex} are estimated and found to agree with experimental data. (auth)

19009 SHRINKING, NONSHRINKING, AND EXPANDING DIFFRACTION PEAKS. Islam, M. M. (Brown Univ., Providence). Contract AT(30-1)-2262. Ann. Phys. (N. Y.), 41: 177-204 (Feb. 2, 1967). (NYO-2262-117).

An explanation of the shrinking, nonshrinking, and expanding diffraction peaks at high energy ($\gtrsim$ 10 BeV) is given in terms of two kinds of forces: due to the exchange of the π-π $J^{PG} = 0^{2+}$, T = 0 antibound state or virtual state, and due to the exchange of the $J^{PG} = 1^{2-}$ vector meson ($\omega + \varphi$). It is shown that the energy dependence of the diffraction peaks can essentially come from the vector meson exchange force, because this force falls off more slowly at high energy than the other force. Thus, for π^+p and π^-p scattering, as the vector meson force does not occur, there is little energy dependence or nonshrinking diffraction peaks. For pp and K^+p scattering, the vector meson exchange force can have asymptotic behavior such that it decreases absorption as the energy increases and this behavior then gives shrinking diffraction peaks. For $\bar{p}$p and K^-p the vector meson exchange force changes sign and as a result, the absorption now increases as the energy increases. This behavior produces expanding diffraction peaks. The absorption (or inelasticity) at high energy was dynamically related with the input forces, in the framework of an impact parameter formalism. The asymptotic behavior, which is found for the vector meson force, is explained in terms of a suitably constructed Mandelstam double spectral function. This explanation also indicates how the compositeness of the vector meson comes about. On the basis of unitarity argument, it is pointed out that the vector meson cannot behave as an elementary particle. The incident and the outgoing particles are treated as spinless. (auth)

19010 UNITARIZED IMPULSE APPROXIMATION: KD ELASTIC SCATTERING. Brehm, J. J. (Northwestern Univ., Evanston, Ill.). Ann. Phys. (N. Y.), 41: 434-41(Feb. 17, 1967).

An effort is made to incorporate unitarity into the dispersive impulse approximation for KD elastic scattering. It is argued that elastic unitarity suffices since there exist no inelastic two-body states of any kind (involving stable or unstable particles) coupled to the KD system at low energy. The impact parameter representation is used and an approximate unitarity relation is obtained. Correct threshold behavior for the partial waves is built in and a unitarized version of the impulse approximation is constructed. The cross sections are calculated at 230 MeV/c. Little data are available for comparison with the computed angular distribution; the total cross section is in excellent agreement with experiment. (auth)

19011 THERMODYNAMIC APPROXIMATION FOR TRANSVERSE MOMENTUM DISTRIBUTION OF SECONDARY PIONS. Kajzar, F. (Jagellonian Univ., Krakow). Acta Phys. Pol., 31: 231-9(Feb. 1967).

The formulas for the transverse momentum distribution based on the thermodynamic approximation of phase-space integrals are applied to π^-p interactions at 10 GeV. It is shown that the thermodynamic approximation with the correction of the order of n^{-1} agrees very well with the experimental data. The agreement is much better than for the transverse momentum distributions proposed up to now. (auth)

19012 THE CASCADE DECAY $N^*(2825) \rightarrow \rho + N^*(1236)$. Skrobis, K. (Jagellonian Univ., Krakow). Acta Phys. Pol., 31: 417-19(Feb. 1967).

The possible decay of the nucleon isobar $N^*(2825) \rightarrow \rho + N^*(1236)$ is studied and discussed in detail. The cms coordinate frame is chosen with the z axis parallel to the relative three-momentum of the initial meson (π) and nucleon and the relative three-momentum of the ρ and $N^*(1236)$ particles lies in the xz plane. (J.F.P.)

19013 THREE QUARK MODEL OF BARYONIC STATES WITH A NONLOCAL SEPARABLE POTENTIAL. Deloff, A. (Inst. for Nuclear Research, Warsaw). Acta Phys. Pol., 31: 333-48(Feb. 1967).

A nonrelativistic quark model of baryonic states is presented The quarks interact via SU_3, and SU_2 (spin) invariant, two-, and three-body nonlocal separable potential. The potential contains spin and unitary spin exchange terms. The baryonic states are supposed to furnish L = 0 and L = 1 (positive and negative parity) multiplets. For the states of assumed symmetry the appropriate integral equations are derived and solved approximately in order to obtain the binding energies. In the case of the two body interaction the model provides the required, strong binding only in states $L = 1^+$, and the states L = 0 and $L = 1^-$ are not bound unless three-body forces are introduced. With three-body forces it is quite easy to obtain strong binding in all states considered. (auth)

19014 SINGLE-NUCLEON STATES IN A MODEL WITH A FIXED SOURCE. Gostev, V. B.; Frenkin, A. R. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 169: 1300-3(Aug. 21, 1966). (In Russian).

In investigating meson-nucleon resonances, simple models of field theory with a fixed source are of interest. Certain features of the meson-nucleon system can be followed, since the model shows three possible nucleon states. An exact solution of the Schroedinger equation is given without the use of series summing of perturbation theory. The model considers four types of particles: the fixed fermions A, B, and C, which can be looked upon as nucleons and the excited state of a nucleon, and the relativistic boson θ. The Hamiltonian of the system is written with operators for the generation (or disappearance) of the particles A, B, C, and θ, which obey the Fermi-Bose rules of commutation. The Schroedinger equation is equated to the Hamiltonian by the relations between the wave functions. An integral equation is solved to give an expression for $\psi(\omega)$, which was confirmed by substituting in the original integral equation. The appearance of two single-particle A-states is possible. (TTT)

19015 ESTIMATION OF THE EFFECTS OF DIFFRACTION SCATTERING IN PRODUCTION PROCESSES. Fraser, G.; Roberts, R. G. (Imperial Coll. of Science and Tech., London). Nuovo Cimento (10), 47A: 293-8(Jan. 21, 1967).

It was suggested that diffraction scattering in particle production processes can produce effects very much like resonance production. It is shown that such effects are very unlikely, and that the diffraction scattering contributes mainly to the background processes. (auth)

19016 STRONG INSTABILITY AND SELF CONSISTENCY. Grodsky, Irvin Terrill. St. Louis, Washington Univ., 1966. 87p.

Thesis.

An investigation is made of the general problem of incorporating strongly unstable particles into S-matrix calculations with a particular emphasis upon self-consistency applications. The difficulty resides basically in the fact that unstable particles generate complex singularities on unphysical sheets, thus making their presence known in the usual formulation only via contributions to the physical cuts. Since most of the information contained in these singularities appears in the physical many-body discontinuities, it would appear that only a direct attack upon many-body scattering and production amplitudes could suffice in yielding a calculational method general enough to include these contributions. However, recent work has shown that the discontinuities across these unphysical cuts can probably be decomposed into distinct pieces, each directly assignable to a specific singularity. This result is proved from field theory in the static limit. In particular, the two-body type cut on the third sheet can be split into a pure unitarity-like elastic contribution from a well defined unphysical amplitude plus a contribution from the "residual inelasticity," i.e., from the three-body threshold that would exist if the resonance did not obtain. It is shown that the resulting structure is just what one generates via a continuation in the mass of the particle in question from a stable value to an unstable one. A calculational method is proposed which consistently ignores the residual inelasticity, but retains the important unphysical amplitude unitarity contribution directly due to the existence of the resonance. This allows unstable particles to be treated on an equal footing with stable systems, thereby eliminating the "sick cut" dilemma. Unstable particles can be included as exteral particles in a scattering process (albeit unphysical), and multi-channel systems, either stable or unstable, can be correctly treated uniformly using only two-body methods. As an application of the method, the πN, πN^* system is treated in the static limit in a full two-channel calculation. A computer solution was obtained in which a strong self-enhancement was found in all channels. Self-consistency between input and output was excellent (violation <7%) except for the $\pi N^* N^*$ coupling constant (violation ~20%). This coupling constant appears only as a factor in the residue of the N^* pole in the highly unphysical πN^* elastic scattering channel and could well possess a significant imaginary part, which was ignored. It is noted that the analysis is particularly useful in the investigation of any system in which there is a transition between stability and instability. (Dissertation Abstr.)

Strong (Baryon No. ≥ 2)

19017 ON THE BINDING OF Σ^-nn. Bhaduri, R. K.; Nogami, Y.; Van Dijk, W. (McMaster Univ., Hamilton, Ont.). Nucl. Phys., B1: 269-76(1967).

The possibility of a bound Σ^-nn system is examined in the light of recent experimental data of Dosch et al. on Σ^+-p elastic scattering. A singlet Σ^--n potential that gives a bound state at zero energy, and the strongest possible triplet Σ^--n potential that is compatible with experimental data, are constructed in the Moszkowski-Scott spirit. It is concluded that a bound Σ^-nn cannot exist. The lowest-order three-body forces in Σ^-nn are briefly examined, and it is argued that these are likely to be unimportant. (auth)

19018 EVIDENCE FOR ΛNN REPULSIVE FORCES FROM p-SHELL HYPERNUCLEI Gal, A. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Rev. Lett., 18: 568-71(Apr. 3, 1967).

A strongly repulsive three-body ΛNN force is proposed for the explanation of some exceptionally large binding-energy differences in the p-shell hypernuclei. It is argued that heavy hypernuclei maintain their stability. (auth)

19019 FINAL STATE Λ-NEUTRON INTERACTIONS IN $\gamma + d \rightarrow K^+ + \Lambda + n$. Renard, F. M.; Renard, Y. (Univ., Paris, Orsay, France). Phys. Lett., 24B: 159-62(Feb. 6, 1967).

In order to clarify the results for Λ−N interaction parameters, the final-state interaction $\gamma + d \rightarrow K^+ + \Lambda + n$ is studied. The K^+ spectrum and its deformation due to the low energy Λ − n interactions are examined, and comparison with experiment allows the determination of the S-wave effective range parameters. The dynamics of this reaction is divided into two steps: the production amplitude mainly dominated by the relativistic impulse amplitude, and the final-state interactions between the three produced particles. (J.F.P.)

19020 ANALYSIS OF THE ELASTIC SCATTERING OF PROTONS AT HIGH ENERGY AND MOMENTUM TRANSFER USING THE SERBER MODEL. Avison, David (Brown Univ., Providence). Phys. Rev., 154: 1570-82(Feb. 25, 1967). (NYO-2262TA-129).

Serber's model for describing proton-proton scattering is investigated in detail at two laboratory momenta, 11.26 and 30.0 GeV/c, by carrying out a partial-wave computation with the potential $A = (A_\phi, \mathbf{A}) = (i\eta e^{-\Delta z}/r, 0, 0, 0)$ inserted into the Klein-Gordon equation $[(P_{op} - A)^2 + m^2]\psi = (E - A_\phi)^2\psi$. The two resulting momentum-transfer distributions obtained differ from those obtained by Serber, who used an optical approximation. Both curves are raised above Serber's in the high-momentum-transfer region. This causes the 11.26-GeV/c curve to be in better agreement with the data and the 30.0-GeV/c curve to overshoot the data, yielding worse agreement. The raising of these momentum-transfer curves in the high-momentum-transfer region is due to the appearance of a real part in the low-angular-momentum contributions to the scattering amplitude. (auth)

19021 DETERMINATION OF THE NUCLEON–NUCLEON ELASTIC-SCATTERING MATRIX. V. NEW RESULTS AT 25 MeV. Arndt, Richard A.; MacGregor, Malcolm H. (Univ. of California, Livermore). Phys. Rev., 154: 1549-57(Feb. 25, 1967). (UCRL-70075).

Analyses of N-N experiments at 25 MeV have been hampered by a lack of complete scattering data, especially for the scattering states with isotopic spin T = 0. In particular, there is an ambiguity in the single-energy T = 0 solutions at 25 MeV. This ambiguity, which is discussed here in detail, is partly resolved by the addition of new (n,p) data. Some new (p,p) data were also added. The resulting phases more closely resemble the values expected from potential models—with which they are compared. The new selection of data permits a determination of the pion-nucleon coupling constant ($g^2_{\pi} = 14.3 \pm 1.3$), whereas the older selections did not. An investigation of the parabolic approximation for each of the phases indicates the extent to which one can believe the uncertainties as given by an error-matrix calculation. The energy-dependent analyses in this energy region were improved by having the S phases extrapolate to the scattering length and effective-range expansions at low energies. The resulting phases give excellent fits to the data at 10 MeV as well as at 25 MeV. Experiments that would further improve the analysis at 25 MeV are suggested. The present results are in some disagreement with a recently released Dubna analysis at 23 MeV. (auth)

19022 DISPERSION THEORETIC IMPULSE APPROXIMATION: KD ELASTIC SCATTERING. Brehm, J. J. (Northwestern Univ., Evanston, Ill.). Ann. Phys. (N. Y.), 41: 423-33 (Feb. 17, 1967).

Dispersion theory techniques are applied to construct an impulse approximation model for K^+-meson-deuteron elastic scattering. The discontinuity of the annihilation amplitude on the $N\bar{N}$ cut is examined for small deuteron mass. Analytic continuation in the deuteron mass yields an anomalous cut; it is this contribution which is isolated and interpreted as the impulse approximation. For low energies an s-wave scattering length approximation is used for the KN amplitude. The spins of the particles are taken seriously throughout. The angular distribution for a lab momentum of 230 MeV/c is calculated and compared with existing data. (auth)

19023 MODEL FOR HIGH-ENERGY SINGLE-PION PRODUCTION. Fraser, G. M. (Imperial Coll. of Science and Tech., London); Roberts, R. G. Nuovo Cimento (10), 47A: 339-42 (Jan. 21, 1967).

A possible mechanism for the background production of single mesons (π) in high-energy reactions is investigated. The background production considered is direct production, that is, without any intermediate resonance or bound state being formed which may subsequently decay to give an indirect production process. The processes considered are $\pi^+ + p \rightarrow \pi^+ + \pi^0 + p$, $\pi^+ + p \rightarrow \pi^+ + \pi^+ + n$, and $p + p \rightarrow p + p + \pi^0$. Several features which would be exhibited by all these reactions over a range of incident meson (π) momenta are presented. (J.F.P.)

Particle Invariance Principles and Symmetries

General

19024 DISCRETE SERIES FOR THE UNIVERSAL COVERING GROUP OF THE 3 + 2 DE SITTER GROUP. Evans, N. T. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 8: 170-84(Feb. 1967).

A classification is given of the irreducible unitary representations of the universal covering group of the 3 + 2 de Sitter group which contract to the usual physical representations of the Poincaré group. These representations include the discrete series for the 3 + 2 de Sitter group. The classification problem is reduced from one for the group to the corresponding one for the Lie algebra. The method used by Thomas for the representations of the 4 + 1 de Sitter group is then followed, except that a representation is reduced out with respect to the irreducible unitary representations of a noncompact 2 + 2 subalgebra. It is conjectured that each representation of this subalgebra occurs at most once. The action on the representation spaces of a basis for the Lie algebra is given. The contractions of the representations to those of the Poincaré, oscillator and the Galilei groups are briefly considered. (auth)

19025 STRUCTURE OF THE CROSSING MATRIX FOR ARBITRARY INTERNAL SYMMETRY GROUPS. II. MATRICES IN SU(n). Fairlie, D. B. (Univ. of Durham, Eng.). J. Math. Phys. (N. Y.), 8: 185-8(Feb. 1967).

It is shown that in SU(n) two distinct processes can give rise to identical crossing matrices in general. In SU(2) and SU(3), however, the crossing matrix corresponds to a unique scattering process, and thus the dynamical equations in the elastic channel are sufficient to discriminate between different processes. Some SU(n) crossing matrices, which generalize the work of Cook, Muturza, and Rashid, are given. (auth)

19026 EXTRACTING INFINITE-DIMENSIONAL UNITARY REPRESENTATIONS OF SU(2,2) IN A FREE PARTICLE BASIS. Ingraham, R. L. (New Mexico State Univ., University Park). pp 375-406 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

The infinite dimensional unitary representations of SU(2,2), which includes the Poincaré group properly, are sought in a basis in which the free particle quantum numbers — momentum, spin, and helicity — are sharp. A general method based on Schur's Lemma is used. New insights are gained into the problem of synthesizing the Poincaré group and internal symmetries, which are: the explanation of continuous mass spectra within supermultiplets; new sources and possibilities for internal quantum numbers; the existence of massive SU(2,2)-invariant fields; and the convenience of space-time dependent similarity transformations to change to familiar bases of irreducible states. Mathematical details of partial solutions are summarized in part II. (L.B.S.)

19027 HARMONIES IN THE MOTION OF CELESTIAL BODIES UNDER NEWTONIAN ATTRACTION. Sudarshan, E. C. G. (Syracuse Univ., N. Y.); Mukunda, N. pp 407-18 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966. (NYO-3399-38).

Invariance principles for dynamical systems that lead also to invariance groups of the Hamiltonian are considered. Energy level degeneracy for the hydrogen atom is considered in the equivalent one-body problem, which is the analog of the mass degeneracy for the two-particle system in interaction in its center of mass frame. The choice of the group 0(4) and the larger groups 0(4,1) and 0(5) is discussed. It is then shown how the invariance groups and noninvariance groups can be studied within the framework of the classical theory of the Newtonian potential. (L.B.S.)

19028 A SIMPLE DISCUSSION OF SU(3) AND SU(6). Faeldt, Goeran (Univ. of Lund, Sweden). Physics, 3: No. 1, 47-67(Jan. 1967).

An elementary derivation of some basic properties of the unitary groups SU(3) and SU(6) used in current particle physics is given. No new results are presented, but an introduction for the nonspecialist is given. The derivation of the representations of SU(3) and SU(6) and the grouping of particles into multiplets are considered. Mass formulas and magnetic moments, as well as many other applications, can be worked out with the same method but only the background is given; the detailed applications are omitted. The group SU(2) is reviewed with special attention to properties independent of dimensions. (auth)

19029 DYNAMIC GROUP AND SU(n)-SYMMETRY OF OSCILLATOR. Sannikov, S. S. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 12: 339-41(Feb. 1967). (In Russian).

Dynamic groups and properties of quantum mechanical systems related to the dynamic group are discussed. The dynamic group describes a noncompact group encompassing all energy spectra of the system and the multiplicity of degeneration of each energy level (or the compact Hamiltonian symmetry group). An analysis is made of an n-dimensional isotropic oscillator from the point of view of its dynamic group. It is known that the Lorentz group L_3 is the dynamic group of the one-dimensional oscillator vectors of which states form two irreducible concepts $D^+(1/4)$ (the paired levels) and $D(3/4)$ (the unpaired levels). The close bond between the SU(n)-symmetry and the dynamic group is analyzed for the case of n-dimensional oscillator. (R.V.J.)

19030 BREAKDOWN OF REFLECTION SYMMETRIES. Low, Francis E. (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 1: No. 1, 1-4(Jan. 1967).

The three invariance principles C, P, and T, which were once thought to hold exactly in nature, are briefly discussed. The significant developments and experiments which lead to the discovery of the breakdown of P and CP are pointed out. (L.B.S.)

19031 LORENTZ COMMUTATORS OF INTERNAL DYNAMICAL VARIABLES. Fleming, Gordon N. (Pennsylvania State Univ., University Park). Phys. Rev., 154: 1475-6(Feb. 25, 1967).

A definition of internal dynamical variables which includes the unitary-spin generators is used to determine the pure Lorentz commutators of these variables in the presence of nonconserving interactions. A geometrical interpretation of the nonvanishing Lorentz commutators is presented in terms of the hyperplane formalism. (auth)

19032 A FEW COMMENTS ON THE REPRESENTATIONS OF SU(3). Resnikoff, M. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 15: 255-63(1966).

Using Schur's lemma, the representations $D^{\lambda\mu}$ are shown to be irreducible. An alternate derivation of Weyl's character formula is obtained by summing the diagonal representatives of $D^{\lambda\mu}$. Finally, the normalized differential volume element dV for the Murnaghan parameterization of SU(3) is included. (auth)

19033 MIXING SCHEME FOR CHIRAL AND COLLINEAR ALGEBRAS. Ademollo, M.; Gatto, R.; Longhi, G.; Veneziano, B. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cimento (10), 47A: 334-8(Jan. 21, 1967).

The probable complication of acceptable saturation schemes for the chiral algebra commutators at infinite momentum is investigated in relation to the implicit noncollinearity in the definition of the electric-dipole operators. (J.F.P.)

19034 APPROXIMATE SATURATION OF THE ALGEBRA OF AXIAL CURRENTS. Longhi, G. (Istituto Nazionale di Fisica Nucleare, Florence). Nuovo Cimento (10), 47A: 282-92(Jan. 21, 1967).

The saturation of the commutation relations of the space components of the axial currents with multiplets of $SU_3 \times SU_{3W}$ is considered, taking into account possible Schwinger terms. It is shown that the saturation with the states of the 56^+ multiplet is not consistent with a momentum transfer dependence. This dependence can be obtained, without a renormalization of the static SU_6 results, by adding to the 56^+ a negative-parity multiplet. Even without specifying this multiplet the results $\langle r_n^2 \rangle = 0$, and $D/F = 3/2$ up to first order in the momentum transfer can be obtained. (auth)

19035 THEORY OF SPINORS. Cartan, Elie. Cambridge, Mass., Massachusetts Institute of Technology Press, 1967. 165p. $7.00.

Representations of orthogonal groups with either real or complex parameters, including reflections, and the related groups with indefinite metric are described. The treatment emphasizes the geometrical point of view. The general theorems of Weyl, and Peter and Weyl on complete reducibility and existence of representations of a general class of groups are stated without proof, but the results are demonstrated explicitly for the orthogonal groups. The derivation of the Dirac equation for any group and its extension to general relativity is given. Also the relation of the Clifford algebras to the orthogonal groups is shown briefly. (J.F.P.)

Applications (Electromagnetic and Weak)

19036 G_2 AS A PARTICLE SYMMETRY. Behrends, R. E. (Yeshiva Univ., New York). pp 363-73 of Lectures in Theoretical Physics. Volume VIII B. Fundamental Particles and High Energy Physics. Brittin, Wesley E.; Barut, A. O. (eds.). Boulder, Colo., University of Colorado Press, 1966.

A survey is given of some recent work which has been done on G_2 as a particle symmetry. Predictions for the weak decays are discussed according to three classes: those which hold to all orders in the symmetry breaking interaction β, those which hold to the first order $0(\beta)$, and those which are violated to $0(\beta)$. Predictions of the G_2 model for bosons are also discussed. It is shown that the objectionable predictions of G_2 for electromagnetic prop-

erties of baryons can be changed by introducing the symmetry breaking interaction. (L.B.S.)

19037 VIOLATION OF CP INVARIANCE. Okun', L. B. Usp. Fiz. Nauk, 89: 603-46(Aug. 1966). (In Russian).

The discussion of CP invariance includes properties and decays of neutral mesons (K), various electromagnetic interactions and decay processes, weak currents, and various weak decays. Also covered are the absolute difference between particles and antiparticles, absolute spirality, and mirror particles. (J.F.P.)

19038 C VIOLATION IN ETA DECAY? Fitch, Val L. (Princeton Univ., N. J.). Comments Nucl. Particle Phys., 1: No. 1, 5-7(Jan. 1967).

A summary is given of results of experimental tests for C noninvariance in eta decay, which followed recent suggestions that the explanation for CP violation in K_2^0 decay could be found in strong or electromagnetic interactions. It is expected that very definite statements can be made about the nature of the CP violation in K_2^0 decay of the present limits on the neutron electric dipole moment can be substantially extended. (L.B.S.)

19039 MASS SPLITTING IN THE CURRENT-CURRENT PICTURE. Chiu, Y. T.; Schechter, J. (Univ. of Chicago). Contract AT(11-1)-264. Nuovo Cimento (10), 47A: 214-21(Jan. 21, 1967). (COO-264-326).

By assuming the electromagnetic and medium-strong mass splitting interactions to be bilinear products of octet currents, each set of octet baryon splittings can be calculated in terms of one parameter with reasonable experimental agreement. (auth)

19040 ALGEBRA OF CURRENTS AND P-WAVE NONLEPTONIC HYPERON DECAYS. Fayyazuddin; Riazuddin (International Atomic Energy Agency, Trieste, Italy). Nuovo Cimento (10), 47A: 222-31(Jan. 21, 1967).

It is shown that the chiral $SU_3 \otimes SU_3$ algebra of currents and the partially conserved axial vector current hypothesis do not lead (in the current-current picture) to the $\Delta I = \frac{1}{2}$ rule for p-wave Λ and Ξ decays nor to a "pseudo" $\Delta I = \frac{1}{2}$ rule for the p-wave Σ decay, contrary to what was obtained for the s-wave decays. Instead one only obtains some relations among deviations from the $\Delta I = \frac{1}{2}$ rule and deviation from the Lee–Sugawara sum rule. (auth)

19041 CRITICAL EXPERIMENT FOR THE HYPOTHESIS OF NEUTRAL LEPTON CURRENTS IN CP-ODD $|\Delta S| = 1$ SUPERWEAK INTERACTION. Lipmanov, E. M. (Volgograd State Pedagogical Inst.). JETP Lett. (USSR) (Engl. Transl.), 5: 104-6(Feb. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 129-31(Feb. 15, 1967).

The hypothesis that the neutral lepton currents take part in the new CP-odd superweak interaction with $|\Delta S| = 1$ was previously formulated. The search for decay meson (μ) pairs on the first few centimeters of the meson (K^0)-beam path is a critical experiment for this hypothesis. It is found that apparently experimental conditions are favorable for searches of electron pairs from the decay $K_2^0 \rightarrow \pi^0 + e^+ + e^-$ (J.F.P.)

19042 WEAK INTERACTIONS AND ELEMENTARY PARTICLE SYMMETRIES. Pakvasa, Sandip Shirish. Lafayette, Ind., Purdue Univ., 1966. 87p.

Thesis.

The relation between weak interactions and symmetries of strongly interacting particles is reviewed. A brief historical sketch of various theories of weak interactions and symmetries is given. Nonleptonic decays are studied in the light of the successful symmetry scheme SU(3). The discussion is centered around the possible derivations of the Sugawara-Lee triangle sum rule. A similar discussion in the scheme W_3 is given. In W_3 a very simple derivation of the triangle sum rule is given and also a prediction about the decay $\Sigma^+ \rightarrow n + \pi^+$ being pure P-wave is made. After a brief introduction to the recently proposed SU(6) scheme, leptonic decays of baryons are studied in SU(6) by extending Cabbibo's theory to SU(6). The decay rates predicted for hyperon leptonic decays are found to be in good agreement with experiment. Rates for leptonic decays of Ω^- are also predicted. In a similar study of nonleptonic decays of hyperons it is found that the assumption of minimal symmetry breaking is at variance with experiment. Arguments for a reasonable assignment of nonleptonic decays are given and the consequences of this assignment studied. It is found that the discrepancy with experiment is removed and the triangle sum rule is predicted for the S-wave amplitudes. The $\Sigma^+ \rightarrow n + \pi^+$ is predicted to be pure P-wave. Ω^--decay amplitudes are found to be related to and expressed in terms of known hyperon decay amplitudes. Finally, weak interactions are studied in the relativistic versions of SU(6), viz., SU(12) and $\bar{U}(12)$. It is found that the results are exactly the same as in SU(6). (Dissertation Abstract)

Applications (Strong)

19043 (JINR-P2-3170) GIPOTEZA ADDITIVNOSTI I MASSOVYE FORMULY DLYA ADRONOV. (Hypothesis of Additivity and Hadron Mass Formula). Slavnov, A. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1967. 7p. (In Russian). Dep. mn.

Mass formulas which describe the unitary multiplet splitting are obtained on the basis of additivity hypotheses for the hadron scattering amplitude. No assumptions are made on transformation properties of the SU_3-breaking symmetry interaction. (auth)

19044 (JINR-P2-3217) NOVYE EKSPERIMENTY NA POLYARIZOVANNYKH MISHENYAKH. (Ideas on New Experiments on Polarized Targets). Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1967. 17p. (In Russian). Dep. mn.

A possible application of polarized proton targets and polarized proton and antiproton beams to the direct testing of T,P,C invariance and the CPT-theorem is considered. It is pointed out that the account of N-N and $\bar{N}$-N scattering bremsstrahlung causes deviation from the equation P = A. A part of bremsstrahlung whose spectrum is proportional to $d\omega/\omega$ does not affect the relation P = A, the deviation from which begins from the $\sim d\omega$ spectrum part. The result of A. V. Tarasov's consideration is given. The P-invariance can be tested both in the up-down asymmetry measurement and in the total cross section measurements using the polarized beam and the polarized target. Also, as has been noted previously, the study of polarization effects provides a possibility for testing C,P,T and CPT-invariances. If there is no P-parity violation, the measurement of $\sigma_{P_1P_2}$ is of interest for testing higher isotopic symmetries. It is noted that the direct determination of forward scattering amplitudes is simplified when measuring $\sigma_{P_1P_2}$. (J.F.P.)

19045 REFORMULATION OF THE SU_3 SYMMETRY. Zaikov, R. G. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 19: 775-8(1966).

From the reformulation of SU(3) symmetry it is found that if quarks exist there can be nine different kinds of them. These quarks are listed in a short table. (J.F.P.)

19046 SATURATION OF CURRENT ALGEBRA EQUATIONS WITH HIGHER BARYONIC RESONANCES. Gatto, R.; Maiani, L.; Preparata, G. (Univ., Florence). Physics, 3: No. 1, 1-16(Jan. 1967).

The saturation of the commutation relations of the chiral $U(3) \otimes U(3)$ algebra with supermultiplets of SU_6 or $SU_6 \otimes O_3$ is considered. The general helicity dependence of the matrix elements of axial charges at $p = \infty$ is calculated. A continuity postulate is introduced to select the physically significant solutions from the multiplicity of solutions of the nonlinear set of saturated commutator equations. A linearized approach is developed to derive criteria of "connection" between two supermultiplets with respect to the chiral algebra and to calculate the renormalizations (at second order) of the couplings. The possible relevance of the connection criteria and of the compatibility with data of the coupling renormalizations to discriminate among various possibilities of classification of higher resonances is pointed out. Special cases discussed are classifications of negative parity resonances according to the representations and 56 of SU_6 and (20, L = 1) of $SU_6 \otimes O_3$. Only the last one gives consistent predictions. (auth)

19047 APPROXIMATE FOUR DIMENSIONAL SYMMETRY AND HADRON SPECTROSCOPY. Domokos, G. (Univ. of California, Berkeley). Phys. Lett., 24B: 293-6(Mar. 20, 1967).

Consequences of an approximate SO_4 symmetry on the hadron spectrum are discussed. Several hadrons can be consistently assigned to even "daughters" of top-ranking Regge trajectories. (auth)

19048 BARYON–MESON COUPLINGS IN BROKEN $SU(6)_W$. II. Gupta, Sachchida Nanda (National Physical Lab., New Delhi). Phys. Rev., 154: 1456-9(Feb. 25, 1967).

The baryon-meson vertex is studied within the framework of broken $SU(6)_W$ symmetry. The breaking is provided by a W = 1 spurion transforming like the I = O = Y member of the adjoint 35 representation of $SU(6)_W$ and which belongs to an SU(3) octet and/or SU(3) singlet. The spin kinematic factor in this case is different from the W = O spurion breaking. The present type of breaking forbids all decuplet decays of the type $D \rightarrow B + P$, and in this respect the present situation resembles that of the static $SU(6)_s$ in exact symmetry. The BBP couplings are related, in general, by 5 parameters which, under certain simplifying assumptions, reduce to a smaller number. Sum rules are listed for all the possibilities that might arise, and it is found that the predictions for the symmetry broken by a W = 1 spurion belonging to an SU(3)

octet plus an SU(3) singlet—both in the same 35 representation—are consistent with the present knowledge of the couplings. (auth)

19049 DYNAMICAL SYMMETRY AND HADRON MASS-SPECTRUM. Stoyanov, D. T.; Todorov, I. T. (Joint Inst. for Nuclear Research, Dubna, USSR). Ann. Phys. (N. Y.), 41: 349-71(Feb. 17, 1967).

The semidirect product of the Poincaré group with U(6,6) is considered, in which the noncompact internal symmetry group U(6,6) is an invariant subgroup. The hadrons are classified in the "ladder" (unitary, infinite-dimensional) representations of U(6,6). The mass-square operator is defined in terms of a "dynamical" four momentum. A method of successive approximations is proposed for the calculation of its eigenvalues. The first approximation is in good agreement with experiment in the case of baryons, while in the meson case the results are less satisfactory. (auth)

19050 THE BARYON SPECTRUM IN SU_3-SYMMETRIC STRONG COUPLING THEORY. Dullemond, C.; von der Linden, F. J. M. (Univ., Nijmegen, Netherlands). Ann. Phys. (N. Y.), 41: 372-408(Feb. 17, 1967).

A spectrum representing the masses of baryons is obtained using strong coupling theory in SU_3 invariant interactions between a baryon octet and a pseudoscalar meson octet. The spectrum appears to be independent of the F/(F + D) mixing ratio, as long as this parameter (α) lies between 0 and 0.725. In that case a baryon octet with spin $\frac{1}{2}$ appears as the ground state, immediately followed by a decuplet with spin $\frac{3}{2}$. The first multiplet following that is an antidecuplet with spin $\frac{1}{2}$. This is immediately followed by a {27} representation with spin $\frac{3}{2}$ and a {35} representation with spin $\frac{5}{2}$. (auth)

19051 SYMMETRIC THREE-QUARK INTERACTIONS. Werle, J. (Univ. of Warsaw). Acta Phys. Pol., 31: 397-403(Feb. 1967).

A simplified treatment of three-quark interactions is proposed. It is based on the nonrelativistic three-particle hamiltonian which is invariant under the group O_6. Such a symmetry implies that the strongest interactions between quarks are essential three-body interactions. Two-body interactions break O_6 and are responsible for the mass splitting which is two orders of magnitude smaller. The proposed O_6 symmetry simplifies considerably the discussion of energy levels. (auth)

Quantum Field Theories

19052 (ARL-66-0206) PROBLEMS RELATING QUANTUM THEORY TO THE GENERAL THEORY OF RELATIVITY. Schiller, Ralph (Stevens Inst. of Tech., Hoboken, N. J.). Oct. 1966. Contract AF 33(657)-11558. 70p.

The quantization of the gravitational field is considered. In particular it is shown that a linearized gravitation theory may be transformed into a problem in electrodynamics. Some issues about the definition of energy in relativity are raised. Relations between classical physics and the expectation value equations of quantum theories describing mass particles with internal degrees of freedom are explored. The expectation value equations for spin-$\frac{1}{2}$ and spin-1 particles are closely related to equation of motion derived from classical covariant field theory, e.g., the general theory of relativity. In addition a new quantum theory whose starting point is the classical equations of motion including damping but interpreted as Heisenberg equations of motion is considered. This approach seems to throw new light on renormalization problems in quantum field theory and gives rise to the hope that field theories of a conventional type may be constructed without some of the present divergence difficulties. (auth)

19053 CONSTRUCTION OF A GAUGE-INVARIANT CUTOFF OF QUANTUM ELECTRODYNAMICS FROM A NONLOCAL GAUGE-INVARIANT LAGRANGIAN. Fraas, H. (Deutsches Elektronen-Synchrotron, Hamburg). Z. Phys., 200: 375-97 (Mar. 14, 1967).

A nonlocal gauge-invariant Lagrangian is given, which describes gauge-invariant quantum electrodynamics with a modified fermion propagator. Some examples are discussed. (auth)

19054 CONDITIONS Z = 0 IN SCALAR FIELD THEORY. Braun, M. A. (Leningrad State Univ.). Nucl. Phys., B1: 277-82 (1967).

The conditions Z = 0 are studied in a scalar field theory. It is shown that under certain additional assumptions they describe standard theories of composite particles. The equivalence of the bootstrap and the composite particle theory is also demonstrated. (auth)

19055 POINT-LOOP RENORMALIZATION IN REGULARIZED FIELD THEORIES. I. Frank, William M. (Weizmann Inst. of Science, Rehovoth, Israel). J. Math. Phys. (N. Y.), 8: 194-200 (Feb. 1967).

The relation between the augmented and the standard vacuum amplitudes is derived (for a finite-valued amplitude for the point fermion-antifermion loop) by diagrammatic methods. This relation is shown to consist of a mass renormalization, whereby the point fermion-antifermion loop is absorbed into the fermion propagator, plus some additional factors, and the analytical properties of the amplitudes are greatly modified. The effects of the renormalization are the increase of the density of zeros, the increase of the exponential order in the variable z, and the change of the singularities in η from simple poles to essential singularities. The significance of these for massless fermions or bosons is briefly discussed. (auth)

19056 LAMB SHIFT AND VALIDITY OF QUANTUM ELECTRODYNAMICS. Drell, Sidney D. (Stanford Univ., Calif.). Comments Nucl. Particle Phys., 1: No. 1, 24-7(Jan. 1967).

The validity of quantum electrodynamics at arbitrarily small distances is challenged, which led to extensive work and progress in the direction of high- and low-energy experiments in recent months. The new experimental results and theoretical refinements of the Lamb shift, which point to a serious disagreement, are viewed to be among the most significant. (L.B.S.)

19057 EXPERIMENTAL CHECKS OF QUANTUM ELECTRODYNAMICS. Wilson, Richard (Harvard Univ., Cambridge, Mass.). Comments Nucl. Particle Phys., 1: No. 1, 20-3(Jan. 1967).

A summary is presented of improved measurements and calculations in quantum electrodynamics, which may have resolved discrepancies between experiment and theory for the cases of hydrogen hyperfine structure and photoproduction of electron-positron pairs, and opened one for the case of the Lamb shift. (L.B.S.)

19058 MULTIMASS FIELDS, SPIN, AND STATISTICS. Feldman, G. (Johns Hopkins Univ., Baltimore); Matthews, P. T. Phys. Rev., 154: 1241-9(Feb. 25, 1967).

The most general free field which transforms locally under Lorentz transformations according to a unitary representation of the homogeneous Lorentz group is constructed. Such a field is a linear combination of annihilation and creation operators for particles belonging to an infinite tower of irreducible multiplets of the Poincaré group. Different spin multiplets in the tower may have different masses, and appear with arbitrary spin-dependent and mass-dependent weight factors in the field expansion. It is shown that the requirement of causal (anti-)commutation relations for these fields can be satisfied simply if one assumes Bose statistics for the particles in the towers for both integer and half-odd-integer spin. However, by a judicious use of the Gelfand matrices (generalized Dirac matrices) the causality condition can also be satisfied using Fermi statistics. Such Fermi fields are constructed for two particular unitary representations—one of integer and one of half-odd-integer spin. These generalized Fermi fields still do not enable one to construct an index invariant theory consistent with the unitarity of the S matrix which incorporates particles satisfying Fermi statistics. Thus the incompatibility for an index-invariant causal theory between unitarity and Fermi statistics, which was established in a previous paper under more restrictive assumptions, remains valid for these more general fields. (auth)

19059 SOLUTION OF THE BETHE–SALPETER EQUATION IN THE INELASTIC REGION. Levine, M. J. (Univ. of California, San Diego, La Jolla); Wright, Jon; Tjon, J. A. Contract AT(11-1)-Gen-10. Phys. Rev., 154: 1433-7(Feb. 25, 1967). (UCSD–10P10-12).

The Bethe-Salpeter equation is solved numerically for a ϕ^3 theory in the ladder approximation up to the second inelastic threshold. Below the first inelastic threshold, the results agree with previous work. Between the first and second inelastic thresholds, it is found that there are coupling strengths which cause unitarity ($\sigma_{total} \geq \sigma_{elastic}$) to be violated. (auth)

19060 ENERGY MOMENTUM SPECTRUM OF QUANTUM FIELDS. Kadison, Richard V. (Univ. of Pennsylvania, Philadelphia). Commun. Math. Phys., 4: 258-60(Feb. 17, 1967).

It is proved, assuming Einstein causality, that the energy-momentum spectrum of a quantum field cannot be bounded. More is known under special assumptions. The main concern is the method and general applicability of the result. (auth)

19061 SPECIAL FORM OF THE ELECTRON PROPAGATOR. Tatur, S. (Univ., Warsaw). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 15: 31-2(1967).

Relativistically invariant positively definite spectral representation for the electron propagator in the lowest order of perturbation theory in quantum electrodynamics is obtained. (J.F.P.)

19062 ON THE FIELD THEORETIC FUNCTIONAL CALCULUS FOR THE ANHARMONIC OSCILLATOR. I. Maison, D.; Stumpf, H. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Z. Naturforsch., 21a: 1829-41(Nov. 1966).

The many-time and one-time functional calculus is developed for the anharmonic oscillator in analogy to the requirements of nonlinear spinor theory. The N.T.D.-method is discussed for the eigenvalue functional equation. It is shown that the N.T.D.-method admits different representations, namely a symmetric one and an unsymmetric one. The proof of convergence is given for the symmetric one. The connection between the unsymmetric and the symmetric representation is discussed and numerical values in comparison with Schrödinger theory are given. (auth)

19063 METHOD OF SECOND QUANTIZATION. Berezin, F. A. Pure and Applied Physics. A Series of Monographs and Textbooks. Volume 24. New York, Academic Press, 1966. 237p. $10.00.

The application of quantum mechanics to systems containing a variable number of particles is considered. The basic premises, the relation between vectors and functionals, basic rules for operating on functionals, quadratic operators and the related linear canonical transformations, and Wick's theorem are discussed. Quantum field theory is treated by means of the four-fermion model of Thirring. (J.F.P.)

19064 DYNAMICS OF A CUT-OFF $\lambda\Phi^4$ FIELD THEORY. Jaffe, Arthur Michael. Princeton, N. J., Princeton Univ., 1966. 220p.

Thesis.

Two models for a cut-off boson field theory are studied by Hilbert space techniques. A spin zero field is self coupled by an interaction such as $\lambda\phi^4$, which formally leads to a positive total energy. The Hamiltonian is cut-off so that the total Hamiltonian is defined in Fock space; it is shown to be essentially self adjoint on a natural domain, and to have a unique ground state, or "vacuum." The total Hamiltonian is used to propagate the field from its given value at $t = 0$, and hence to define an interacting field at all times. This interacting field satisfies a nonlinear equation of motion (interpreted in the appropriate sense of distribution), and it satisfies the canonical commutation relations. In addition, the smeared field operators can be applied to a dense set of states in the Hilbert space, and any polynomial in these smeared fields can be applied to the vacuum. Thus there exists an invariant domain for the field operators and a set of vacuum expectation values for the theory; it is also shown that the time-ordered vacuum expectation values (Green's functions) exist. The vacuum expectation values and Green's functions satisfy, in the sense of distributions, an infinite set of coupled partial differential equations. These equations are exactly those equations which result from varying the cut-off Lagrangian in the old-fashioned, formal manner. It is shown that the method can not be applied to the $\lambda\phi^3$ theory, in which the energy is formally unbounded below. A number of properties of the $\lambda\phi^4$ solutions are studied, such as their asymptotic behavior in space and time, and their analyticity in the coupling constant. For example, the solutions are not analytic in the coupling constant λ at zero coupling and therefore do not have a convergent perturbation expansion at $\lambda = 0$. Nevertheless they are analytic in a neighborhood of every point on the real, positive λ axis. The effect of adding a quadratic term to the Hamiltonian is investigated. It is shown independently of perturbation theory that such a term can be interpreted as a mass renormalization. There are two equivalent formulations of the same theory, an unrenormalized and a renormalized scheme. Both lead to the same vacuum expectation values, and hence to the same physics. Finally, it is shown that in the case of a quadratic interaction Lagrangian, the cut-off can be removed, and a relativistic theory is recovered from the limiting vacuum expectation values. (Dissertation Abstract)

Scattering Theory

Refer also to abstract 19016.

19065 (AD-634844) DERIVATION OF THE PRINCIPLE OF COMPENSATION OF DANGEROUS DIAGRAMS. Kobe, Donald H. (Uppsala Univ. (Sweden)). Oct. 15, 1964. Contract AF 61(052)-701. 29p. (ARL-66-0122). CFSTI $3.00 cy, $0.65 mn.

The compensation of the lowest order dangerous diagram is analogous to a Hartree-Fock procedure to determine the coefficients for the Bogoliubov quasi particles. This procedure is generalized in analogy with the Brueckner extension of the Hartree-Fock procedure by replacing the potential with the reaction operator (t-matrix) to obtain the principle of compensation of dangerous diagrams (PCDD). The PCDD is expanded by time dependent perturbation theory to third order, and it is shown that ladder diagrams are not important. (auth)

19066 MULTIPLE DISPERSION RELATION FOR SHORT-RANGE POTENTIAL, WHICH IS NOT ALLOWED TO OVERLAP THE YUKAWA-POTENTIAL. Guenther, U.; Janssen, H. K. (Technische Hochschule, Aachen). Z. Phys., 200: 366-74 (Mar. 14, 1967). (In German).

A triple dispersion relation is derived for the function $f(s,t,u)$ which becomes the scattering amplitude $f(s,t)$ for $u = 4s - t$. Besides the usual conditions which are needed for deriving a dispersion relation in s, the potential must decrease faster than exponentially at infinity. For this class of potentials $f(s,t,u)$ has essential singularities for $t \to \infty$ and $u \to \infty$. It is shown that $f(s,t,u)$ is bounded in the physical sheets of two independent Riemannian surfaces which are constructed by conformal mappings of the t- and the u-plane. In the new variables the conditions for the existence of dispersion relations are fulfilled. (auth)

19067 TEMPERATENESS OF THE ABSORPTIVE PART OF THE SCATTERING AMPLITUDE IN THE PROOF OF DISPERSION RELATIONS. Dobson, Peter N. Jr. (Univ. of Hawaii, Honolulu). J. Math. Phys. (N. Y.), 8: 315-19(Feb. 1967).

A proof is given within the context of the Bremermann, Oehme, and Taylor proof of dispersion relations that the absorptive part of the elastic scattering amplitude remains tempered throughout the relevant region of analytic continuation. The technique of this proof, which avoids the use of the Jost-Lehmann-Dyson representation, may be applicable to some field theories which do not assume local commutativity and for which such a representation cannot, therefore, be constructed. (auth)

19068 CONSISTENCY CONDITIONS ON MODELS FOR HIGH ENERGY SCATTERING. Eden, R. J. (Cambridge Univ., Eng.). J. Math. Phys. (N. Y.), 8: 320-5(Feb. 1967).

From unitarity, analyticity in t, and analyticity in E, a variety of conditions can be derived for the high-energy behavior of a crossing symmetric two-body scattering amplitude $F(E,t)$. These conditions are studied as consistency conditions for a class of models for high-energy scattering based on smoothly varying functions. For this class of models they lead to: (1) the Froissart bound without making explicit use of Martin's enlargement of the Lehmann ellipse, (2) conditions on the phase of the amplitude and its derivative with respect to t in the forward direction. As an example of the use of the phase conditions, it is shown how the Lehmann ellipse can be enlarged to give analyticity in the circle $|t| < R$, where R is fixed. Although the method is different, this result is closely related to the general results of Martin, but with our smoothness assumptions a little more detail can be stated about the behavior of $F(E,t)$. (auth)

19069 REGGE POLES AND THE SCATTERING OF UNEQUAL MASS PARTICLES. Oakes, R. J. (CERN, Geneva). Phys. Lett., 24B: 154-6(Feb. 6, 1967).

It is suggested that a Regge trajectory $\alpha(t)$ generally will also have angular momentum components $\alpha_\lambda(t) = \alpha(t) - \lambda(\lambda = 1, 2, \ldots)$ associated with it for all t which become redundant whenever $\alpha(t)$ makes a particle. (auth)

19070 UNITARY AND NONUNITARY REPRESENTATIONS OF THE COMPLEX INHOMOGENEOUS LORENTZ GROUP. Roffman, Eric H. (New York Univ.). Commun. Math. Phys., 4: 237-57 (Feb. 17, 1967).

Unitary and nonunitary representations of the complex inhomogeneous Lorentz group, including all its unitary, irreducible representations are constructed. The decomposition of these representations when they are restricted to the real inhomogeneous Lorentz group is discussed. Also discussed are the representations of the Poincaré group for which the translation subgroup transforms under a not necessarily unitary representation. The physical motivation for this study is briefly summarized. (auth)

19071 UNIQUENESS AND SYMMETRY BREAKING IN S-MATRIX THEORY. Lovelace, C. (CERN, Geneva). Commun. Math. Phys., 4: 261-302(Feb. 17, 1967).

Assuming that the physical world is a solution of the S matrix equations, nonlinear functional analysis enables its uniqueness to be tested experimentally. As a first step, such tests are developed within the limits of partial wave dispersion relations, with crossing symmetry included. They are closely related to Levinson's theorem. It is shown that they give conditions for the validity of the bootstrap hypothesis, of the dynamical generation of symmetries, and of Dashen-Frautschi perturbation theory. They do not appear to be satisfied experimentally. (auth)

19072 EXAMPLE OF AN INELASTIC BOUND STATE. Bronzan, J. B. (Stanford Univ., Calif.). Contract AT(04-3)-400. Phys. Rev., 154: 1545-9(Feb. 25, 1967). (SLAC-PUB-202).

An example is given of a bound state which occurs in a channel with a repulsive Born approximation. The bound state occurs because of the attraction provided at low energy by three-particle intermediate states. (auth)

19073 BOUND-STATE SOLUTIONS OF THE SCHRODINGER EQUATION. Eyges, Leonard (Air Force Cambridge Research Labs., Bedford, Mass.). Phys. Rev., 154: 1207-17 (Feb. 25, 1967).

A new method is presented for solving the Schrödinger equation for attractive potentials. The basic idea is to use in conjunction both the differential and integral forms of the equation. In one dimension, for example, a formal solution for $\psi(x)$ can be found from the differential equation; since this is of second order, the solution is fixed, in principle, by $\psi(0)$ and $\psi'(0) \equiv d\psi/dx|_{x=0}$. These quantities are in fact unknown, but from the integral equation we can calculate integral expressions for them. The formal solution is inserted into the integrands of these expressions and $\psi(0)$ and $\psi'(0)$ are eliminated from the resulting equations to get an equation for the energy eigenvalues. In three dimensions, the method works much the same way. In terms of $Q_l(r)$, where the radial wave function $R_l(r)$ for the lth angular momentum state is $R_l(r) = r^l Q_l(r)$, it leads to the basic equation for the eigenvalues, $1 = -[Kv_0(ik)^l/1 \times 3 \times 5 \times \cdots \times (2l+1)] \int_0^\infty h_l(iKr')\, u(r') r'^{l+2} dr'$, where K^2 is essentially the magnitude of the energy, and the potential is written as $-v_0 u(r)$. For nonsingular potentials, the formal solution for $Q_l(r)$ can be put in the form $Q_l(r) = S_l(r) + \Sigma_s S_{l,s}(r) U_0^{(s)} + \Sigma_{s,t} S_{l,st}(r) U_0^{(s)} U_0^{(t)} + \ldots$, where $U(r) = v_0 u(r) - K^2$, and where $U_0^{(s)}$ is the sth derivative of $U(r)$ at the origin. The functions $S_l(r)$ and $S_{l,s}(r)$ are calculated, and then the results are applied to the case of a Gaussian potential. A modification of these ideas for singular potentials is also discussed, and is applied to the Yukawa potential. (auth)

19074 NUMBER OF SUBTRACTIONS IN PARTIAL-WAVE DISPERSION RELATIONS. Kinoshita, Toichiro (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 154: 1438-44(Feb. 25, 1967).

Under the usual assumption of unitarity and analyticity for the partial-wave amplitude $f_l(s)$, it is proved that the dispersion relation for $f_l(s)$ requires no more than one subtraction for any angular momentum l, provided that $|f_l(s)| \leq \exp[C(\ln|s|)^{2-\epsilon}]$, $\epsilon > 0$, holds for $|s| \to \infty$, and that the number of times that the sign of the discontinuity $IM\, f_l(s + i0)$ changes in the interval $(s,0)$ does not increase more rapidly than $C'(\ln|s|)^{1-\epsilon}$ as $s \to -\infty$ along the negative real axis. (auth)

19075 GENERAL SOLUTION OF THE ONE-CHANNEL-SCATTERING SINGULAR INTEGRAL EQUATIONS. Ciulli, S.; Ghika, Gr.; Stihi, M.; Visinescu, M. (Inst. for Atomic Physics, Bucharest). Phys. Rev., 154: 1345-57(Feb. 25, 1967).

Integral equations for one-channel scattering are written and solved, starting from dispersion relations for the generalized Jost function in the momentum k plane. This method is an alternative to the conventional N/D method, but it allows a simple, physically meaningful generalization to the many-channel case, where dispersion relations and integral equations can be written for a unique generalized Jost function in the complex plane of a suitable variable which uniformizes all the right-hand cuts of the scattering amplitude. Even in the pure elastic-scattering case, a unified treatment is possible, whether the phase shift at infinity is or is not an integral multiple of π. In all cases, our singular integral equations are reduced to a Fredholm-type integral equation with a Hilbert-Schmidt kernel. (auth)

19076 BAKAMJIAN–THOMAS THEORY AND THE SERBER MODEL. Avison, David (Brown Univ., Providence). Phys. Rev., 154: 1583-92(Feb. 25, 1967). (NYO–2262TA-131).

The Bakamjian-Thomas theory is used to obtain relativistic scattering equations for the relative motion of two particles. These are presented in a squared and in an unsquared form, and both forms are realized in Cartesian coordinates and reduced to partial-wave equations for the case of an isotropic potential dependent only on the Bakamjian-Thomas relative coordinate. These equations are shown to bear a resemblance to the Klein-Gordon equation with Serber's potential A. The first Born approximation of the scattering amplitude computed from the Bakamjian-Thomas equations and that computed from the Klein-Gordon equation are shown to agree as $k \to \infty$. Differences between these approaches are expected to show themselves mainly at large-angle scattering, since the (unsquared) Bakamjian-Thomas Green's function differs appreciably from that of the Klein-Gordon equation only for small r. (auth)

19077 REGGE POLES IN THE SCATTERING OF PARTICLES OF UNEQUAL MASS. REMARK ON A PAPER OF FREEDMAN AND WANG. Durand III, Loyal (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 154: 1537-9(Feb. 25, 1967). (COO–881-85).

An interesting analogy is presented between (i) the properties of the shadow trajectories with singular reduced residues which appear in Regge-pole models for the scattering of particles of unequal mass (Freedman-Wang), and (ii) the well-known infinite-momentum limits of Regge trajectories in potential scattering. A simple model for estimating the effects of those trajectories is presented. (auth)

19078 SEPARABLE EXPANSIONS OF THE TWO-BODY T MATRIX FOR LOCAL POTENTIALS AND THEIR USE IN THE FADDEEV EQUATION. Wong, David Y. (Univ. of California, San Diego, La Jolla); Zambotti, G. Phys. Rev., 154: 1540-5 (Feb. 25, 1967).

An expansion of the off-shell two-body T matrix is introduced in the form of a sum of terms separable in the initial- and the final-momentum variables. The convergence of this expansion is tested against exact solutions of several local potential problems. The substitution of the expansion into the Faddeev equations yields a set of coupled integral equations in one variable. As an example, the binding energy of three identical bosons is calculated using an S-wave Yukawa potential for the two-body interaction. It is found that a stationary state exists for the potential strength $G \geq 1.4$, whereas a two-body bound state requires $G \geq 1.8$. An off-shell effective-range formula is introduced for problems in which the shape of the two-body potential is not well known. It is shown that the difference between the solutions of the Yukawa potential and the exponential potential with the same scattering length and effective range is comparable to the deviation of the off-shell effective-range formula from either solution. (auth)

19079 CONVERGENCE OF APPROXIMATIONS FOR AN S-MATRIX OF SCATTERING IN THE METHOD OF MOMENTS. Kushnirenko, A. N. (Inst. of Problems in Material Studies, Academy of Sciences, Ukrainian SSR). Dopov. Akad. Nauk Ukr. RSR, No. 1, 65-8(Jan. 1967). (In Ukrainian).

Considerations are advanced showing that the sequence of solutions of Schroedinger's equation, obtained by the method of moments, converges to the exact solution of this equation, at any rate, in the generalized sense. (auth)

19080 ESTIMATION OF LOCAL ANISOTROPIC SCATTERING PROPERTIES USING MEASUREMENTS OF MULTIPLY SCATTERED RADIATION. Kagiwada, H. H.; Kalaba, R. E. (RAND Corp., Santa Monica, Calif.). J. Quant. Spectros. Radiative Transfer, 7: 295-303(Mar.-Apr. 1967).

The local anisotropic scattering function is estimated on the basis of knowledge of multiple-scattering properties. The phase function is expanded in a series of Legendre polynomials, and the coefficients are determined so as to best explain diffuse reflection measurements. The quasilinearization procedure for digital computers is described and computational results are given. (auth)

19081 THRESHOLD ANOMALIES. Graves-Morris, P. R. (Cambridge Univ., Eng.). Ann. Phys. (N. Y.), 41: 477-91(Feb. 17, 1967).

The characteristics of various threshold anomalies in cross sections and phase shifts are investigated and categorized. The effects of including a particle of large real mass as a coupled channel are considered, and the usual resonant behavior of physical amplitudes is derived. (auth)

19082 LEVINSON'S THEOREM FOR ENERGY-DEPENDENT POTENTIALS. Calogero, F. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Jagannathan, G. Nuovo Cimento (10), 47A: 178-88(Jan. 21, 1967).

Levinson's theorem is proved for an energy-dependent local potential $V(E,r)$. The main restriction on the potential is given by the inequality $\partial V(E,r)/\partial E \leq 1$; it is sufficient for the validity of the theorem that this condition hold at negative energy for almost all values of r. The physical meaning of this condition is discussed. (auth)

19083 BOUNDS ON SCATTERING PHASE SHIFTS FOR THE DIRAC EQUATION. Epstein, David. New York, New York Univ., 1960. 92p.

Thesis.

The application of the Kato variational principle to the problem of determining upper and lower bounds on the scattering phase shifts for the Dirac equation was investigated. The results of the analysis indicate that, subject to certain difficulties peculiar to the Dirac equation, the Kato principle can be generalized so that useful bounds on the phase shift can often be obtained in the relativistic case. Sufficient conditions on the potentials, under which the monotonicity theorem is valid, have been established. Methods for calculating reasonable lower bounds on the critical eigenvalues, α_ϑ and β_ϑ, are presented. A technique for obtaining bounds on the phase shift directly, based on the approximate wave function $\psi_\Lambda(\varphi)$ with $f_\Lambda(\varphi) \sim \varphi j_{L+1}(\varphi)$ and $g_\Lambda(\varphi) \sim \varphi j_L(\varphi)$, where $\varphi = kr - \int_0^r V(r')dr'$, is developed and applied with some success to scattering from an exponential and a truncated exponential well. Furthermore, it is shown that at high energies, for many non-singular potentials, $\eta_\infty = -\int_0^\infty V(r)dr$, is an upper (lower) bound on the scattering phase shifts. (Dissertation Abstr.)

Particle Accelerators

Refer also to abstract 19152.

19084 (AD-642415) OPERATION, MAINTENANCE, AND DOSIMETRY ON THE AFCRL LINEAR ACCELERATOR, AND RADIATION EFFECTS ON SILICON AND INSULATORS. Final Report, June 15, 1965-August 15, 1966. Mayburg, Sumner; Wall, James A. (Controls for Radiation, Inc., Cambridge, Mass.). Aug. 15, 1966. Contract AF 19(628)-5214. 73p. (AFCRL-66-681). CFSTI $3.00 cy, $0.65 mn.

The operation, maintenance, modifications and addition of instrumentation to the AFCRL linear accelerator during the contract period are discussed. Preliminary work on the dosimetry of the linac electron beam and x-rays is described. A National Bureau of Standards P-2 chamber, a Victoreen r-meter in a lucite equilibrium shell, and a prototype carbon calorimeter were tested for the x-ray dosimetry. The trapping of electrons in an insulator is calculated both during and after a radiation pulse. It is found that for very high and narrow radiation pulses the number of trapped electrons is proportional to the logarithm of the total dose while for low-wide radiation pulses the number of trapped electrons is proportional to the total dose. A simple expression is derived for the conductivity produced in an insulator because of the trapping of electrons. This conductivity decays with the time constant for emission of electrons from the traps. (auth)

19085 (BNL-11142) THREE DIMENSIONAL PROPERTIES OF MAGNETIC BEAM TRANSPORT ELEMENTS. Danby, G. T.; Lin, S. T.; Jackson, J. W. (Brookhaven National Lab., Upton, N. Y.). [1967]. Contract AT(30-2)-Gen-16. 9p. (CONF-670307-16). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Analytical and experimental methods to describe precisely, in three dimensions, the magnetic fields of beam transport elements are discussed. The influence of the fringing field on beam optical properties and magnet design are presented. With appropriate boundary conditions the field components are expressed in terms of the magnetic potential to arbitrarily high orders with empirical coefficients and are grouped in a form to avoid the divergence of higher order terms. As an accurate description of the true field is obtained, a very precise trajectory can be computed for a known momentum. In addition, the more useful inverse problem of finding the momentum of a particle with known input and output trajectory coordinates is attacked. The trajectory solution is expressed as the sum of an analytical part plus perturbation terms. The first order solution for the momentum is easily obtained and the convergence of the subsequent perturbation calculations is very rapid even for extreme rays. The value of this method, with its precise treatment of fringing fields, is emphasized by treating in detail a wide angle spectrometer (120-in. wide, 36-in. long, 24-in. gap) The perturbation technique shows promise that an accurate instantaneous read-out of the momentum can be obtained by employing a modest number of perturbation corrections stored in the memory of the computer. (auth)

19086 (BNL-11148) AGS INJECTOR BEAM MONITORING SYSTEM. Otis, A.; Larson, R.; Lockey, R.; DeVito, B.; van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). [1965]. Contract AT(30-2)-Gen-16. 17p. (CONF-670307-22). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The performance of the AGS depends critically on the linac beam characteristics such as beam intensity, proton momentum, momentum spread and beam transverse phase space distribution. These parameters are measured by pulse deflection of the 50 MeV proton beam into a separate analyzing channel in which continuous beam analysis and monitoring is possible without interruption of regular AGS operation. In addition to a general description of the linac-synchrotron beam transport and analyzing system, details of the momentum spread and monitoring system are presented. (auth)

19087 (BNL-11164) DESIGN FOR A SUPERCONDUCTING QUADRUPOLE. Dahl, P. F.; Parzen, G. (Brookhaven National Lab., Upton, N. Y.). Feb. 14, 1967. Contract AT(30-2)-Gen-12. 12p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A superconducting quadrupole, which has four identical planar coils wound from a thin superconducting ribbon, is described. The current density is varied by varying the spacing of the ribbon. (B.G.D.)

19088 (CERN-67-2) LONGITUDINAL INSTABILITIES OF AZIMUTHALLY UNIFORM BEAMS IN CIRCULAR VACUUM CHAMBERS WITH WALLS OF ARBITRARY ELECTRICAL PROPERTIES. Sessler, A.; Vaccaro, V. (European Organization for Nuclear Research, Geneva (Switzerland)). 1967. 24p. Dep. mn.

The possible longitudinal instabilities of a centrally located beam in a tank of circular cross section is investigated. The tank walls are taken to be non-perfectly conducting and to have some distributed transverse admittances and longitudinal impedance. (B.G.D.)

19089 (JINR-P9-3165) ISPYTANIE OTKLONYAYUSHCHEGO USTROISTVA ELEKTRODINAMICHESKOGO SEPARATORA CHASTITS VYSOKIKH ENERGII. (Test of Deflector for High Energy Particle Electrodynamic Separator). Mukhin, S. V.; Popov, V. A.; Rikhvitskii, S. V.; Semenyushkin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 11p. (In Russian). Dep. mn.

The results of tests of the deflector for the high energy particle electrodynamic separator with π-meson beam are reported. For the chosen geometry of the separator the maximum deflection of the 4.95 GeV/c particles is equal to $\Delta\alpha = \pm 2.8$ mrad at hf power of 1.5 MW(e), the electric field intensity being 22 kV/cm. (auth)

19090 (LA-DC-8343) HIGH DUTY FACTOR RF SOURCES AT 800 MHz. Hagerman, Donald C. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 14p. (CONF-670307-17). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

The proton linear accelerator for the Los Alamos Meson Physics Facility will require 45 one-megawatt, 800-MHz rf power sources. The minimum duty factor requirement is 6% (500 μs pulse 120 c/s); eventually, a 12% duty factor (1000 μs pulse 120 c/s) will be needed. The accelerator structure which is the load for the amplifier has a high Q (typically between 20,000 and 30,000); the amplifier loading is further complicated by a variable beam load which may absorb as much as 30% of the amplifier output. Triodes, klystrons, and crossed-field amplifiers all show promise for this service. The Los Alamos Scientific Laboratory is testing and comparatively evaluating these three rf systems. The systems are described and a discussion of the evaluation program is given. (auth)

19091 (LA-DC-8346) OPTIMUM GENERATOR CHARACTERISTICS OF RF AMPLIFIERS FOR HEAVILY BEAM-LOADED ACCELERATORS. Boyd, Thomas J. Jr.; Jameson, Robert A. (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 11p. (CONF-670307-14). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

As the beam loading is increased in a proton linear accelerator, it becomes increasingly more difficult to maintain the design gradient. To avoid excessive beam spill, this gradient must be controlled to a tolerance of ~±1% during the initial transient of beam turn-on and during any subsequent fluctuation in beam loading due to uncontrolled or programmed variations in the amount of beam injected. Since the beam obtains its energy from the field, more power must be supplied by the rf generator when the beam is on. High-power microwave triodes, klystrons, and crossed-field amplifiers are being evaluated as generators to drive the accelerator structure of the LAMPF proton linac. The delivery of power from these tubes to the time-varying load impedance presented by the linac is a complicated interplay among such factors as the internal design of the tube's active region and output coupling section, the length of line between the generator and the load, and the coupling to the load. An optimum system design can enable the generator to provide a degree of self-compensation providing a programmed amount of power to match the changing load impedance. This eases the problem of providing fine control to the 1% tolerance by a closed-loop system. Experimental studies were conducted on each tube type. (auth)

19092 (LA-DC-8383) ADVANCES IN THE DESIGN OF PROTON LINEAR ACCELERATORS: MESON FACTORIES AND INJECTORS FOR SYNCHROTRONS. Nagle, Darragh E. (Los Alamos Scientific Lab., N. Mex.). [1966]. Contract W-7405-eng-36. 8p. (CONF-670307-12). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Some of the worldwide projects to build new linear accelerators are reviewed. Topics include ion sources, beam transport, longitudinal motion, and accelerator structures. (B.G.D.)

19093 (NP-16567) USTOICHIVOST MODULIROVANNOGO PUCHKA V VOLNOVODE, NAGRUZHENNOM DISKAMI. (Stability of Modulated Beam in a Disk-Loaded Waveguide). No. 255/T-041. Kuriiko, V. I. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnischeskii Institut). 1966. 14p. (In Russian). Dep. mn.

The instabilities which lead to the collapse of the charged-particle current in linear accelerators are caused by the excitation of nonaxial-symmetric oscillations of the accelerating system,

such as the disk-loaded waveguide. The growth increment of the instability was examined for the case of a modulated beam in a disk-loaded waveguide, without limitation as to the length of the section, the current, and the ratio of the resonance and modulated frequencies. The calculations revealed that beam modulation causes an increase of the threshold current only under the condition of $\delta \ll \Gamma, \gamma$, whereby δ is the frequency difference, Γ the attenuation decrement, and γ the growth increment. For a given current, the depth of modulation does not affect the growth increment of the instability. In case of lack of matching with the frequency of the defocusing oscillation, the instability becomes absolute and the field increases exponentially with time in any point of the section. Reduction of the threshold current results in an increase of the number of sections, probably because upon leaving the first section, the frequency of the defocusing oscillation becomes modulated; in the subsequent sections the modulation will be amplified because of the excitation of defocusing oscillations. (TTT)

19094 (NP-16635) VLIYANIE VNESHNIKH TSEPEI NA KOGERENTNUYU NEUSTOICHIVOST'. (External Circuit Influence Upon Coherent Instability). Chirikov, B. V. (Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki). 1965. 15p. (In Russian). Dep. mn.

The influence of an external circuit connecting different walls of an accelerator chamber upon coherent instability of the beam is considered. In general the influence is very strong if the walls are not short-circuited. The main result of present calculation is given by the expression for betatron oscillations frequency where terms with C_l – external capacitance per unit length of the chamber, and with R_l – external resistance per unit length, represent an additional effect from the external circuit. The last may explain a big discrepancy between Mills' experimental results and previous theory. On the other hand external circuit may be used to improve suppression of the instability by Landau damping. To get it an external capacitance must have such a value to cancel the real part of frequency shift. For realization this method one should attain very low inductance of the circuit. For the same reason short enough wave-length perturbation can not be stabilized in such a way. (auth)

19095 (NYO-3822-1) WATER COOLED TARGETS FOR INTENSE ION BEAMS. Report No. 645. Hanley, P. R.; Haberl, A. W.; Taylor, A. (Cornell Univ., Ithaca, N. Y. Materials Science Center). Feb. 27, 1967. Contract AT(30-1)-3822. 18p. (CONF-670307-26). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

Target backings cooled by water in linear flow have proven capable of dissipating heat loads from 2 kW ion beams focused to about 20 mm^2 for extended periods without structural failure. In addition to the more obvious modes of failure by plastic deformation and melting, metallographic studies of damaged targets have revealed deep void penetrations along grain boundaries. The targetry limitations imposed on maximum usable beam power by heat transfer from the backing to the cooling fluid were investigated. Neutron producing lifetimes of LiF targets were compared for different proton beam and coolant flow conditions. (auth)

19096 (RHEL-R-135) BEAM MEASUREMENTS DURING THE COMMISSIONING OF THE HARWELL VARIABLE ENERGY CYCLOTRON, DECEMBER 1965–AUGUST 1966. Bennett, J. R. J.; Coupland, J. H.; Jones, E. J.; Lawson, J. D.; Mayhook, A. R.; Randle, T. C.; Trew, D. H. (Rutherford High Energy Lab., Chilton (England)). Dec. 1966. 30p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 4s.

The performance of the Harwell VEC during the first nine months of operation is described. The various diagnostic techniques employed, and their relative value in setting up the machine and assessing its performance are discussed. Some typical measurements are presented, with a discussion of the problems of their evaluation and interpretation. The period covered was mainly occupied by internal beam studies, before the deflector was installed, but the first measurements of the extracted beam are also included. (auth)

19097 (UCRL-70199) DESIGN OF AXIALLY SYMMETRIC ELECTRON GUNS. Beal, Jack W. (California Univ., Livermore. Lawrence Radiation Lab.). Jan. 30, 1967. Contract W-7405-eng-48. 6p. (CONF-670307-9). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From National Particle Accelerator Conference, Washington, D. C.

In the design of high-perveance electron beam devices, it is necessary to evaluate the effects of the self-fields on the beam trajectories as well as the effects of any external electromagnetic fields that may be present. A means whereby the self-consistent solution of Poisson's equation, the relativistic equations of electron motion, and the equation of charge continuity all subject to specified boundary conditions, are determined by means of a digital computer program, is described. In particular the method is applied to the case of an axially symmetric, solid-beam electron gun where the electrons are emitted with zero initial velocity from a space-charge-limited cathode. (B.G.D.)

19098 (AD-646930) NONFERROUS ACCELERATOR OF CHARGED PARTICLES. Abramyan, E. A.; Budker, G. I.; Naumov, A. A. Translation of Russian Patent 168808. 6p. (FTD-HT-66-603). CFSTI $3.00 cy, $0.65 mn.

A nonferrous charged-particle accelerator that contains a vacuum chamber, resonator, injector, and current-conducting buses is described. It is distinguished by the fact that an equalizing central bus is used to accelerate particles of the same sign in opposite directions. The accelerator is designed in the form of a nonsymmetrical racetrack to assure the intersection of particle beams. (auth)

19099 (CONF-660939-7) INTERACTIONS OF COHERENT BETATRON OSCILLATIONS WITH EXTERNAL SYSTEMS. Dikanskii, N. S.; Karliner, M. M.; Skrinskii, A. N.; Shapiro, V. E.; Shekhtman, I. A. Translated by Igor N. Sviatoslavsky from Paper Presented at International Symposium on Electron and Positron Storage Rings, Saclay, France, September 26–30, 1966. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

It was discovered that in storage ring VEPP-2, accelerated damping of betatron oscillations cannot be explained by the finite conductivity of the chamber walls. In connection with this, the interaction of the beam with various types of parasitic dissipative systems is investigated. It is shown that for a given frequency of betatron oscillations it is possible to have accelerated damping as well as self-excited coherent oscillations depending on the resistance of the interacting element for combination frequencies. The obtained decrements and increments can considerably exceed the values caused by the finite conductivity of the chamber walls. (auth)

19100 (LA-tr-65-31) ITEP PROTON SYNCHROTRON INJECTOR. Lapitskii, Yu. Ya.; Khoroshkov, V. S.; Onosovskii, K. K. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from report No. 381. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.60 fs, $0.80 mf.

The improvements recently made on the ITEP proton synchrotron injector are described. The operation regime and the injector operation experience are discussed. After installation of a new ion source (maximal emission current in the pulse 0.3 A) the following working parameters were achieved: operation voltage – 4 MeV, proton current at the entrance into synchrotron's chamber – up to 10 ma with the pulse length 20 μsec. (auth)

19101 PHYSICS WITH LARGE CYCLOTRONS. Merrison, A. W. (Daresbury Nuclear Physics Lab., Eng.). Z. Naturforsch., 21a: 1748-50(1966).

The physics done with large cyclotrons in the last 10 years is outlined, with particular reference to experiments done with the 600-MeV cyclotron at CERN. (auth)

19102 TECHNOLOGY OF INTENSE DC ION BEAMS. Morgan, O. B.; Kelley, G. G.; Davis, R. C. (Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26. Rev. Sci. Instrum., 38: 467-80(Apr. 1967). (ORNL-P-2609).

The present status of a program directed toward the improvement of ion sources and the technology of intense dc ion beams is described. The work is in the energy range of from 20–600 keV at currents of up to 1A. Several factors have differentiated the approach from that existing in some other areas of ion beam research. There are severe cooling problems in the ion source and in beam targets. Grids cannot be used in the electrode system, and many of the techniques which have been used to study detailed emittance shapes are very difficult to utilize because of these thermal problems. On the other hand, it is possible to accumulate electrons in these dc beams to eliminate the dispersive effect of space charge. Pulsed beams with on-times of less than a few hundred microseconds ordinarily are completely unneutralized. Ion sources are described which are especially suited to proton production and to molecular ion production at source arc currents of up to 50 A. Single gap accelerating and focusing arrangements are described. A special configuration prevents electron trapping and subsequent breakdown in the combined electric and magnetic fields. (auth)

19103 EMPEROR TANDEM ACCELERATOR RESEARCH PROGRAM. Bromley, D. A. (Yale Univ., New Haven). Nuovo Cimento (1), 4: Suppl., 560-602(1966).

The design of the Emperor tandem accelerator is given, and the various experiments proposed using this accelerator are de-

scribed. These experiments include neutron threshold measurements, inverse giant resonance, nuclear spectroscopy, particle-gamma and gamma-gamma correlation, the shell-model structure of 3^- collective states, isobaric spin, the decay of T = 2 states, multigap spectrography, and Coulomb excitation. Also discussed are heavy ion studies, heavy ion elastic scattering, spectroscopy with heavy ions, heavy ion transfer reactions, and reactions in the region of the Coulomb barrier. (J.F.P.)

19104 NEW LOOK AT THE CYCLOTRON FOR MAKING SHORT-LIVED ISOTOPES. Ter-Pogossian, Michel M. (Washington Univ., St. Louis); Wagner, Henry N. Jr. Nucleonics, 24: No. 10, 50-6(Oct. 1966).

The use of cyclotrons for making short-lived isotopes for biology and medicine is discussed. Topics discussed are advantages of positive ion accelerators for production of short-lived isotopes, energy considerations, and cost considerations. Two cyclotron produced nuclides, ^{11}C and ^{15}O, are discussed, as to their importance in biology and medicine. (B.G.D.)

19105 THE 42-MeV BETATRON FOR MEDICAL TREATMENTS. Egea, Enrique; Garcia-Orcoyen, S. Energ. Nucl. (Madrid), 10: 411-18(Sept.-Oct. 1966). (In Spanish).

The construction of the shielded enclosure and the calculation of the shielding required for the 42-MeV Medical Betatron are described. (J.S.R.)

19106 A STUDY OF ELECTRON LOADING IN THE ACCELERATING TUBE OF VAN DE GRAAFF GENERATOR. Hsu, Chuchung; Tohei, Tsutomu; Nakagawa, Takemi; Morita, Susumu (Tohoku Univ., Sendai). Jap. J. Appl. Phys., 6: 530-5(Apr. 1967).

X-ray spectra and energy distribution of electrons accompanying the electron loading in the accelerating tube of Van de Graaff generator were obtained in the energy region of proton from 2.2 to 4.0 MeV. It was found that most of the loading electrons are accelerated through about 30 to 40 sections of accelerating tube which consisted of 100 sections. The higher energy component of electrons accelerated up to 70 sections are produced at the accelerating voltage beyond $E_p = 3.45$ MeV. The intensity of electron increases rapidly with the beam energy. (auth)

19107 ABOUT THE PROTON 300 GeV SYNCHROTRON PROJECT: PROBLEMS OF FOUNDATIONS OF THE LARGE ACCELERATORS OF PARTICLES. Mallet, Charles; Gervaise, Jean (CERN, Geneva). Ind. At., 11: No. 1-2, 41-58(1967). (In French).

The problems of the foundations for the great particle accelerators are dealt with, on the one hand by comparing them with those raised by the great civil engineering works, especially dams, and on the other hand in terms of the results obtained from the accelerators in operation: the proton synchrotron of 28 GeV at the CERN and the one of 33 GeV at Brookhaven. The stability of rocky masses is studied by modern methods of geotechnics; a new formulation for calculating vertical movements is given here, as well as the results of measurements of trilateration carried out on standard terrain for measuring the differential displacements of the superficial rock layers. (auth)

19108 TELEMANIPULATION IN A BIG ACCELERATOR. Richter, Wolfgang; Ellefsplass, Melvin; Horne, Roger-Alan (CERN, Geneva). Ind. At., 11: No. 1-2, 77-85(1967). (In French).

The problem of remote handling in the tunnel of an accelerator is reviewed. Periodic maintenance work which must be carried out in highly radioactive zones is described. Different possible installations for a manipulator within the CERN PS are discussed before giving the system which was finally chosen. A detailed description of the equipment is included, together with the new techniques involved. The first experiments carried out during trials outside the ring tunnel are outlined, as well as ideas for future development. (auth)

19109 INVESTIGATION OF AUTO-RESONANT PARTICLE ACCELERATION BY ELECTROMAGNETIC WAVES. Vorob'ev, A. A.; Didenko, A. N.; Ishkov, A. P.; Kolomenskii, A. A.; Lebedev, A. N.; Yushkov, Yu. G. At. Energ. (USSR), 22: 3-6(Jan. 1967). (In Russian).

The characteristics of the autoresonant acceleration of fast wave particles in smooth wave guides were examined. The results were confirmed by experiments conducted at 10-cm wave lengths. The maximum electron energy was about 700 keV. (tr-auth)

19110 OPEN-CAVITY RESONATOR FOR THE RADIO-FREQUENCY RANGE. Andreev, V. G. Zh. Tekh. Fiz., 36: 1851-9(Oct. 1966). (In Russian).

A new type of open-cavity resonator with an expanded area of applications and increased frequency range was investigated theoretically and experimentally. The resonator is composed of two parallel, coaxial, highly conductive disks with the space between them occupied by a number of washer-like rings of smaller diameter at equal or progressively changing distance between them. An analytical method is presented for calculation of the system's parameters. The method is then used for the determination of the dimensions of resonators excitable in the TM_{02n} mode. The results are presented in a series of graphs showing the dependence of the resonance wavelength on the geometry of the system, the effect of the diameter of the end disks on the radiation into space, the effect of the position of the connecting rods, and the loss of high-frequency energy in the rings and in the end disks. An experimental model of the resonator was built and investigated in the SHF (10-cm wavelength) range. With metal connecting rods, the resonance frequency was 3120 Mc; when plastic rods were used, resonance frequency was 3045 Mc. About 10 to 20 percent of the energy was radiated into space. High-frequency losses were found to depend on the position of the metal connecting rods with respect to the resonator axis, the minimum point coinciding with the position of the zero axial component of the electric field. The natural frequencies of the system (with 7 sections) were investigated within the 2000 to 4000-Mc range. Five frequency groups of transverse magnetic oscillations were detected, of which only one (the TM_{02}) had an electric field on the axis. In addition to radio frequency generation, such resonators will be useful in accelerator and measurement technology. (ATD)

19111 DISTRIBUTION OF CURRENT IN THE CROSS SECTION OF AN ELECTRON BEAM. Moroz, E. M.; Pisarev, V. E.; Solov'ev, N. S. (Lebedev Inst. of Physics, Moscow). Zh. Tekh. Fiz., 36: 1860-63(Oct. 1966). (In Russian).

The crossed slit technique was used to measure the current distribution in the cross section of the 0.8 MeV injector beam of the 680 MeV electron synchrotron. Measurements were made at several points along the beam. The distributions were well represented by two-segment distribution curves (triangular distribution). The maximum current density in the beam was found to increase with increasing beam current, even though the width of the beam also increased with increasing total current. Formulas based on the measured distributions are given, with which one can rapidly calculate the maximum current density in the beam and the extent of the beam in two mutually perpendicular transverse directions from the ratio to the total beam current of the current through a single slit or through a single square or round aperture. The possibility of rapidly evaluating the characteristics of the beam should be useful in practical work with the accelerator. (ATD)

19112 MEASUREMENTS OF EQUILIBRIUM CHARGE STATES OF Br, I, Ta, AND U UP TO ABOUT 200 MeV. Grodzins, L. (Massachusetts Inst. of Tech., Cambridge); Kalish, R.; Murnick, D.; Van De Graaff, R. J.; Chmara, F.; Rose, P. H. Phys. Lett., 24B: 282-5(Mar. 20, 1967).

The charge distribution of Br, I, Ta, and U ions passing through carbon foils and certain gases was determined. The most probable charge versus projectile energy is presented for E_{proj} up to ~200 MeV. The data can be used directly to predict the energy spectrum versus terminal potential for an electrostatic accelerator. (auth)

19113 PRODUCTION OF A HIGHLY POLARIZED NEGATIVE DEUTERIUM BEAM. Grueebler, W.; Koenig, V.; Marmier, P. (Eidgenoessische Technische Hochschule, Zurich). Phys. Lett., 24B: 280-2(Mar. 20, 1967).

A highly polarized negative deuteron beam is produced by the atomic beam method with rf transitions and charge-exchange in thin foils. The transition probabilities and the depolarization by the charge exchange process were determined. (auth)

19114 DOUBLE ANGULAR FOCUSING OF AN ION BEAM IN A MAGNETIC ANALYZER WITH TWO SECTOR FIELDS. Zashkvara, V. V. (Inst. of Nuclear Physics, Alma-Ata, USSR). Zh. Tekh. Fiz., 36: 2035-41(Nov. 1966). (In Russian).

The possibility of compensating the higher order astigmatism of a $\pi\sqrt{2}$-type magnetic spectrometer by employing two sector fields in which the magnetic field strengths vary differently with distance from the axis, is discussed. There is discussed only the case in which the two sector fields have the same central angle and are continuous along a radius, and the source and image are located on the field boundaries as in a conventional $\pi\sqrt{2}$ spectrometer. The variations of the magnetic field in the transition region between the different fields in the two sectors (internal fringe field) are neglected. The vertical (axial) components $H_i^{(i)}$ of the magnetic fields in the two sectors i = 1, 2 are expanded in powers of the radial deviation $q = (r - r_0)/r_0$ from the central trajectory: $H_i^{(i)} = H_0^{(i)}(1 - a_i q + b_i q^2 + c_i q^3 + \ldots)$. The condition for vanishing of the first order axial astigmatism (double focusing) is $a_1 + a_2 = 1$. The total sector angle must also have a specific value, which is $\pi\sqrt{2}$ when $a_1 = a_2 = 1/2$ and is less than but close to $\pi\sqrt{2}$ when $a_1 \neq a_2$. When $a_1 \neq a_2$ it is possible to correct higher order on-axis aberrations by appropriately selecting the coefficients b_i, c_i, ... The

second order on-axis aberrations are calculated, and the values of the b_i for which they vanish, together with other characteristics of the system, are tabulated for a number of different values of the a_1. The second order off-axis aberrations of the tabulated systems were calculated and found to be small, but the calculations of the off-axis aberrations are not given. (ATD)

19115 EFFECT OF BEAM LOAD ON THE DURATION OF CURRENT PULSE IN A MULTISTAGE LINEAR ACCELERATOR. Vishnyakov, V. A.; Grishaev, I. A.; Zykov, A. I. Zh. Tekh. Fiz., 36: 2091-3(Nov. 1966). (In Russian).

The phenomenon of current pulse shortening as a result of load variation was experimentally investigated on a 50-m, 9-stage accelerator with an energy gain of 38 MeV per stage. It was observed that the critical current values at the output of several stages were considerably below the level at which the pulse shortening starts in the first stage. The oscillograms of current pulses corresponding to various current values of the beam showed that the pulse area remains practically constant above the critical current value, despite increasing amplitude of the pulse. Current values at which the pulse shortening occurred were found to diminish from stage to stage, in spite of the increase in electron energy. The relative decrease of the critical current value along the length of the accelerator followed a sloping concave curve which branched somewhat higher for a series of stages than for the single (or first) stage. This indicates an increase in the critical current value as a result of increased particle energy, but the tendency toward lower critical values as the number of stages increases remains apparent. From the measurements it was concluded that the critical current value at the output of a multistage linear accelerator remains considerably below that of any of its single stages. The explanation of the phenomenon may be found in the existence of transverse hybrid waves which are already present in the initial stage at current values much below the critical, and are amplified in subsequent stages. (ATD)

19116 BEAM LOADING OF A LINEAR ELECTRON ACCELERATOR UNDER TRANSIENT CONDITIONS. Grishaev, I. A.; Shenderovich, A. M. Zh. Tekh. Fiz., 36: 2013-16(Nov. 1966). (In Russian).

E. L. Burshteyn and G. V. Voskrensenskiy (Nauchnyye trudy RIAN SSSR, III, No. 3, 1961; Atomnaya energiya, 13, No. 5, 466, 1962) have discussed the nonstationary effects associated with the beam loading of a linear electron accelerator using for this purpose their expressions for the Cherenkov field produced by the beam. The same results are obtained more simply from the energy balance equation. A formula is derived for the energy acquired by an electron in traversing a section of the accelerator as a function of the length of the section, the time of injection, the high frequency power supplied to the accelerator, the velocity of the electrons, the group velocity of the waves, the ratio of the square of the electric field in the accelerator to the high frequency power supplied to it, the linear density of the beam, and the damping constant of the unloaded accelerator tube. It is shown that the last factor can be neglected in practical calculations. A formula is derived for the energy spread of the beam as a function of the pulse duration and the other factors mentioned above. The energy spread is maximum for a pulse duration close to $L(c - v)/cv$, where L is the length of the section, c is the electron velocity, and v is the group velocity of the waves. When the total charge in the pulse (rather than the charge density) is held constant, the energy spread increases monotonically with decreasing pulse duration. For injection of electrons into a storage ring, the energy spread can be significantly reduced when capture into the orbit takes place during a time interval that is shorter than the pulse duration. A good spectrum can also be obtained under conditions of considerable loading by cutting off the initial portion of the beam with a pulsed magnet. (ATD)

19117 PREPARATION OF SEPARATED Mg ISOTOPE TARGETS BY REDUCTIVE EVAPORATION. Szalay, A.; Somorjai, E. (ATOMKI, Debrecen, Hungary). Nucl. Instrum. Methods, 49: 355 (1967).

MgO can be reduced and evaporated, into a thin Mg layer with almost 100% yield. The reduction is effected by Ta powder in a thin Ta tube heated by electron bombardment. A collimated Mg vapor beam emerges from the open end of the Ta tube. (auth)

19118 INVESTIGATIONS OF A LONG-LIVED RADIOFREQUENCY ION SOURCE. Valyi, L.; Gombos, P.; Roosz, J. (Central Research Inst. for Physics, Budapest). Nucl. Instrum. Methods, 49: 316-24(1967).

Performance and operating characteristics were investigated on a radiofrequency ion source with electrodes positioned outside of the discharge tube. The ion current versus extracting voltage curves plotted for various distances between the spherical electrodes are partly linear, partly varying with $V^{1/2}$. Analysis of the ion beam with respect to energy and composition shows for extracting voltage of 2 kV the width of the energy spectrum to be 42 eV, the proton contribution 70%. The gas consumption in this case is 3 cm^3/h for an ion current of 30 μA. The source lifetime is 1500 h. The emittance of the beam obtained with 2 kV extracting voltage was measured as 1.4×10^{-5} cm·rad·MeV $^{1/2}$. Applying a magnetic field the ion current can be increased to 10 mA with 8 kV extracting voltage, 30 cm^3/h gas consumption and rf output of 140 W. (auth)

19119 POLARIZED PROTON TARGETS FOR HIGH ENERGY PHYSICS. I. POLARIZATION PRODUCTION. Borghini, M.; Roubeau, P.; Ryter, C. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 49: 248-58(1967). (In French).

A polarized proton target for high energy physics is described. Designed for the strong focusing synchrotron of CERN, the target crystal is 1.2 cm wide with a 5 cm depth along the beam. Proton polarization in excess to ±70% are obtained in lanthanum-magnesium-nitrate, in a field of 18.5 kG at a temperature of 1.1°K. The magnetic field is vertical and the horizontal cryostat is a new type continuous helium flow system, fed from commercially available 50 liter containers. The free angle around the target is 5 sterad. Proton polarization is measured in a fraction of a second by nuclear magnetic resonance. (auth)

19120 POLARIZED PROTON TARGETS FOR HIGH ENERGY PHYSICS. II. POLARIZATION MEASUREMENT. Borghini, M.; Roubeau, P.; Ryter, C. (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Instrum. Methods, 49: 259-66(1967). (In French).

A nuclear magnetic resonance system, specially designed and integrated to a polarized proton target for high energy physics, is described. The polarization is measured in 10 msec by a frequency modulated Q-meter, through automatic integration of the NMR signal. It is shown that the system, although being as usual not fully linear for high polarization, can be calibrated accurately. The lack of linearity is compensated by a factor which can be extracted by a straightforward method and a precision of ±3% can be achieved. The signal-to-noise ratio of the system is also discussed. (auth)

19121 EFFECTIVE RESOLVING TIME IN COINCIDENCE MEASUREMENTS ON THE CYCLOTRON BEAM. Hrynkiewicz, A. Z.; Kopta, S.; Szymczyk, S.; Walczak, T. (Inst. of Nuclear Physics, Krakow. Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Instrum. Methods, 49: 229-34(1967).

The influence of the hf pulsation of the cyclotron beam and of its modulation caused by the duty cycle on the resolving time in coincidence measurements is taken into account. Formulas for the effective resolving time in gamma-gamma, gamma-particle, and particle-particle coincidence measurements for different ratios of the electronic resolving time to the width of hf bunches and to their repetition period are given. It is shown that the delayed chance coincidence curve can be used for the determination of the cyclotron bunch width. This conclusion was checked by a measurement performed on the beam of the heavy ion cyclotron of the JINR in Dubna. (auth)

19122 TARGET PREPARATION TECHNIQUES. Maxman, S. H. (Univ. of Pennsylvania, Philadelphia). Nucl. Instrum. Methods, 50: 53-60(1967).

The techniques for the preparation of 33 thin film self-supporting and carbon backed targets are described. Target thicknesses range from 10 $\mu g/cm^2$ to 1500 $\mu g/cm^2$. In addition general procedures used in target making are discussed. (auth)

19123 BEAM CENTERING DEVICE FOR NUCLEAR ACCELERATORS. Fauska, H.; Williamson, C. F. (Univ. of Washington, Seattle). Nucl. Instrum. Methods, 50: 91-2(1967). (RLO-1388-9).

A split Faraday cup system for nuclear accelerators was developed that allows continuous monitoring of beam centering while maintaining full accuracy of beam current measurement and charge integration. (auth)

19124 ANALOG SYSTEM DISPLAYING BEAM OPTICS. Rumphorst, R. F.; Sonnemans, M. A. A.; Arnold, H.; Koerts, L. A. Ch. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Nucl. Instrum. Methods, 50: 153-6(1967).

An apparatus designed for fast visual inspection of particle trajectories in beam transport systems is described. It is based on an electrical analog of the thin lens approximation. The unit solves continuously for image formation in both the horizontal and vertical planes simultaneously, displaying the corresponding particle trajectories every 40 msec. (auth)

19125 ELIMINATION OF BEAM-DEFOCUSING EFFECTS DUE TO FILAMENT MAGNETIC FIELDS IN THE ELECTRON GUN OF A LINAC. Narita, Y.; Yamazaki, H.; Ozawa, Y.

(Hokkaido Univ., Sapporo). Nucl. Instrum. Methods, 50: 165-8 (1967).

Beam-defocusing effects of magnetic fields due to the filament current of the electron gun in an electron linear accelerator were eliminated by switch-off of the filament current at the instant of pulsed acceleration. An increase of 30% in beam current density was obtained for the output beam. (auth)

19126 STRETCHED FOIL SAMPLE HOLDER FOR LIQUIDS. Sampson, T. E.; Carpenter, J. M. (Univ. of Michigan, Ann Arbor). Nucl. Instrum. Methods, 50: 179-80(1967).

A very thin walled liquid sample holder was developed which uses the stretched foil technique and is intended for use under atmospheric conditions. The sample holder is a modified version of the one described by Striffler and Carpenter (Nucl. Instrum. Meth., 24: 395(1963)). (B.G.D.)

19127 SIMPLE ELECTROSTATIC DEFLECTING SYSTEM FOR CORRECTING THE BEAM POSITION OF ATOMKI CASCADE GENERATOR. Schlenk, Balint. ATOMKI (At. Kut. Intez.) Kozlem., 8: 344-7(Dec. 1966). (In Hungarian).

The description of a simple electrostatic deflecting system built between the ion source and prefocusing lens is given. The system can be used for controlling of the ion beam position of the ATOMKI cascade generator. (auth)

19128 DATA NEEDED FOR THE DESIGN OF THE SHIELDING FOR THE ACCELERATORS IN THE ATOMKI. Angeli, Istvan. ATOMKI (At. Kut. Intez.) Kozlem., 8: 328-39(Dec. 1966). (In Hungarian).

Data and curves needed for the design of the shielding for the accelerators to be installed at Institute of Nuclear Research of the Hungarian Academy of Sciences, Debrecen, are reported. The data refer to ordinary concrete (2.3 g/cm^3) as a reasonable building material being relatively inexpensive. Norms of radiation protection and safety factors taken into account during the design are also discussed. (auth)

19129 HIGH ENERGY PARTICLE BEAM DUMP AND HEAT SINK. Garwin, Edward L.; Walz, Dieter R.; Jurrow, Joseph (to U. S. Atomic Energy Commission). U. S. Patent 3,315,732. Apr. 25, 1967.

A beam dump for nondestructively absorbing and dissipating very high power accelerator particle beams is described. The apparatus features a cylindrical tank into which coolant is injected tangentially at the periphery along the length of the tank and is removed through outlets along the central axis of the tank. The position of the inlets and outlets causes a spiral rotation of all the coolant past a beam injection window offset from the central axis of the tank, at a velocity such that consecutive beam pulses will strike new increments of water mass to effectively carry off the beam energy. (AEC)

19130 IMPROVEMENTS IN OR RELATING TO INCREASING THE YIELD OF ACCELERATED PARTICLES IN A BETATRON OR SYNCHROTON. (to Ceskoslovenska Akademie Ved). British Patent 1,059,108. Feb. 15, 1967. Priority date Nov. 2, 1962, Czechoslovakia.

A method of increasing the yield of accelerated particles in a betatron or synchrotron by increasing the number of accelerating cycles in a unit of time which comprises of connecting at least part of the magnetic windings of the betatron or synchrotron to a source of alternating current for a period shorter than a cycle at moments corresponding to moments when its voltage is in the vicinity of its maximum and the current close to zero and reversing each half cycle in the direction of the supply current. (B.G.D.)

19131 DEVICE FOR REPLACEMENT OF OBJECTS IN A HIGH-PRESSURE TANK. Minamikawa, Yoshihisa; Katagiri, Shinjiro (to Hitachi, Ltd.). Japanese Patent 1966-7520. Apr. 22, 1966. Filed June 14, 1962.

In high-voltage particle accelerators, the high-voltage generator, accelerating tube, etc., are generally contained in a tank filled at high pressures with an insulating gas, in order to remove dangers to personnel and to minimize installation space. In such accelerators when the need arises for replacement of an electron source the containment tank is usually removed. Consequently, there are involved the troublesome removal and reinstallation of the tank, and the increase in cost due to the loss of insulating gas. By the device proposed, these shortcomings are eliminated and an object such as the electron source can be replaced very easily while maintaining the high gas pressure and even under some high voltage. Onto part of the high-pressure tank is installed an air-tight cylindrical body which is kept air-tight by means of a piston. When replacing the electron source, the cylindrical body is inserted and settles air-tight on the source-holding plate. Then, the piston is lowered to the same position and grabs the electron source with the source protrusions engaging with the hollows on the piston surface. The piston, with the source, is raised for withdrawing the source. For replacing a new electron source in position, the device is operated in reverse. (NSA of Japan)

19132 HORIZONTAL PARTICLE ACCELERATOR. Yamamoto, Yoshihiko (Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7396. Apr. 22, 1966. Filed Mar. 29, 1965.

In the horizontal particle accelerator proposed, the mechanism of supporting the accelerating tube is improved. That is, fine-adjustment devices for holding the accelerating tube horizontally despite the bending and vibrations of the support and vibration-absorbing devices for reducing the vibrations transmitted from the insulated support to the accelerating tube are provided. The accelerator consists of the following: the tank containing the main components of the accelerator, the insulated support running horizontally with one end at least being held at the end of the tank; the accelerating tube running within and in parallel with the insulated support; and the devices, located at suitable points along the length of the accelerating tube, for fastening the accelerating tube to the insulated support. The latter devices are provided with a fine adjuster, which holds the accelerating tube horizontally despite the bending of the insulated support, and with a spring (or a combination of spring and damper) for absorbing the vibrations from the insulated support to the accelerating tube. (NSA of Japan)

19133 HORIZONTAL BRIDGE-TYPE PARTICLE ACCELERATOR. Yamamoto, Yoshihiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7395. Apr. 22, 1966. Filed Mar. 29, 1965.

In the horizontal particle accelerator proposed, improvements in the method of connecting the dividing plates and the insulators, and the insulator (at the end of the insulated support) and the device for holding the end of the insulated support. It consists of the following: the tank, containing the high-voltage electrode, and other components, e.g., the horizontal accelerating tube, connecting to this electrode; the horizontal insulated support, insulating the high-voltage electrode, in which the dividing plates connect together through the insulating bodies; a device for holding the end of the insulated support at the end of the tank with an insulating body between; and a device, installed at the other end of the tank, for holding the other end of the insulated support and for providing the compressive force to absorb the tensile stress occurring in the insulated support. The cross-sectional contact areas of the insulating bodies are made smaller than those of the other members in parallel with them, thus reducing the compressive force. (NSA of Japan)

19134 HORIZONTAL PARTICLE ACCELERATOR. Yamamoto, Yoshihiko (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7394. Apr. 22, 1966. Filed Mar. 29, 1965.

In the horizontal particle accelerator proposed, the drive mechanism for the charge-carrying belt is improved. That is, the horizontally moving belt is moved, always being in contact with the middle part of the surface of the two rotating pulleys (one is the driving pulley and the other the free pulley), and the distance between the two pulleys can be adjusted by means of an adjuster installed outside the tank. It in general consists of the following: the tank containing the main components, e.g., the horizontal accelerating tube etc.; the insulated horizontal support held at one end of the tank; the high-voltage electrode for applying a high voltage to the accelerating tube, which is installed at the other end of the insulated support; and the charge-carrying belt, driven by means of the driving pulley (installed on the side of the tank end) and the free pulley (installed within the high-voltage electrode), which runs through the inside of the insulated support. The rotating axis of the driving pulley, and of the free pulley are not in parallel with each other, the parallelism opening downward, so as for the belt to be in contact with the middle part of the pulley surface. In addition, a device is installed outside the tank, for moving the driving pulley appropriately to adjust the tension of the charge carrying belt. (NSA of Japan)

19135 PARTICLE ACCELERATORS. Yoshino, Kiminobu; Masuda, Seizo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7393. Apr. 22, 1966. Filed Jan. 9, 1965.

In the Van de Graaff particle accelerator proposed, the voltage of the high-tension accelerating voltage is excellently stabilized by placing the electric charge on the charge-carrying belt at a fixed electric current. In the particle accelerator, as is usual, a belt is passed between the corona needle impressed with a high tension dc voltage and the earthing electrode, and the charge is put on the belt from the needle and carried to the accelerating electrode. A couple of vacuum tubes are installed in each of which the anode and cathode are connected in series. The anode in one of the vacuum tubes is connected to one output end of the high dc voltage source with the other output end earthed to ground. The cathode in the other vacuum tube is connected to the corona needle

through a resistance. The grid voltages of the two vacuum tubes are set at the desired values. Thus, the corona current can be maintained at a specified value by changing the internal resistances of the two vacuum tubes in accordance with the change in the current of the corona needle. (NSA of Japan)

19136 BETATRON. Tawara, Hiroyuki (to Hitachi Ltd.). Japanese Patent 1966-7760. Apr. 19, 1966. Filed Aug. 7, 1964.

In the betatron proposed, irradiation with the produced x-rays is improved. That is, without reducing the x-ray intensity (produced in the betatron), the electron-rays contained in the x-ray beam can be removed, thereby protecting the x-ray irradiated patient from skin burns. As is usual, the betatron includes the following: the circular accelerating tube; the electron gun installed onto the accelerating tube; the x-ray producing target located within the accelerating tube; the power source for activating the electron gun; the coil, installed on the inner side of the circular accelerating tube, for expanding the orbit of accelerated electrons; and the power source for exciting the orbit-expanding coil. In addition, an electron-deflecting coil, excited in the synchronism with the orbit-expanding power source, is installed in the path of the produced x-ray beam, and an electron-absorbing plate is placed in the path of deflected electrons. (NSA of Japan)

19137 BETATRON. Suzuki, Tetsu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7398. Apr. 22, 1966. Filed Mar. 5, 1965.

In the betatron proposed, the cooling of the inner sections of the magnetic poles is simplified. In a betatron, in general, the magnetic flux density due to the inner sections for providing the magnetic fluxes to the stable orbit must be very high, compared with that due to the outer sections for the stable orbit, with the result of the larger loss of iron in the inner sections. And providing these portions with special cooling devices is not possible, due to the necessity for the symmetric construction of the magnetic pole. Thus, the rise in temperature of the inner sections becomes very considerable, making it impossible to operate the betatron continuously. A frame, made of a material of high heat conductivity and good electric insulation, is attached around the outside of the inner section of the magnetic pole. This frame is wound with a coil of pipe, made of a material (e.g., copper) of good heat and electric conductivities. The pulsed current for controlling the electron orbit flows through the material of the piping. For the cooling of the inner section, a cooling fluid is passed through the tube. (NSA of Japan)

19138 THE MAGNETIC POLE FOR A BETATRON. Suzuki, Tetsu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7399. Apr. 22, 1966. Mar. 3, 1965.

The magnetic pole proposed has the following advantages: the considerable improvement of the magnetic rotation symmetry, the minimization of the increase in the cost of materials; the remarkable reduction in the required adjustment and the resultant increase in the productivity of betatrons, the uniformity in the qualities of the products, etc. The iron core, including the usual inner and outer portions, is made up of three kinds of many narrow fan-shaped (in the cross section) sections. The sections constituting part of the inner portion are made of a material with high saturated magnetic-flux density, e.g., an iron-cobalt alloy; those making up part of the outer portion are of silicon steel plates; and the sections making up part of the inner portion and of the outer portion are made of the same material as in the inner section. The first (inner portion) and the second (outer portion) section connect to each other at the outer and inner, respectively, edges of the two sections; the third (above) section is of the same shape with this connected one. The connected sections and the same-shaped third section are arranged one after the other, describing a circle, which results in the iron core embodying the outer and inner portions. (NSA of Japan)

19139 BETATRON. Takizawa, Teruo (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-7397. Apr. 22, 1966. Filed Feb. 18, 1965.

In the betatron proposed, the iron core can be easily and smoothly divided (into the two halves) and reconstructed, without any facility for this purpose in the betatron room. It consists of the following: the iron core, divisible into two halves, having the magnetic poles for providing the magnetic field and accelerating magnetic fluxes to the circular accelerating tube; the two threaded bars installed on the lower (core) half with a nut engaged with the upper part of the bar; the electric motors for rotating the threaded bars; and devices for fastening together the lower and upper halves into the iron core. (NSA of Japan)

19140 CATHODE FOR A PARTICLE-ACCELERATING TUBE. Saito, Noboru; Wachi, Masaharu (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9754. May 25, 1966. Filed June 30, 1965.

An improved cathode is proposed for a particle-accelerating tube. It consists of the following: a cylindrical metal container; the substance in the container which emits electrons; and the long narrow electron window made on the container wall along the container axis. The electron-emitting substance is supplied by the diffusion to the electron window. (NSA of Japan)

19141 AUTOMATIC CONTROL DEVICE FOR A CHARGED-PARTICLE BEAM. Okawa, Tokio (to Rigaku Denki Co., Ltd.). Japanese Patent 1966-9749. May 25, 1966. Filed Apr. 2, 1965.

By the automatic control device proposed, the fluctuation in the path of a charged-particle beam is detected, and by this detection the position of the electron gun is automatically controlled, thereby correcting the fluctuation in the position of electron injection. A plurality of electrodes, arranged in the form of a circle, surround the path of a charged-particle beam, with the path at the center of the circle; the electrodes are connected to each other through resistances. The charged-particle source is installed so as to be movable. The voltage, produced in each electrode by electrostatic induction due to the movement (fluctuation) of the beam path, is detected, thereby making possible the automatic adjustment of the position of the electron gun. (NSA of Japan)

19142 CONTROL DEVICE FOR PARTICLE ACCELERATORS. Hasegawa, Masaaki (to Matsushita Electric Ind., Co., Ltd.). Japanese Patent 1966-9640. May 23, 1966. Filed Jan. 22, 1965.

The control device proposed for a particle accelerator employs a bistable multivibrator. It consists of the following: a pulse generator for producing a pair of pulses, i.e., start and stop pulses; an electric- to light-signal converter for converting the output pulses to the light pulses; a light-to electric-signal converter for converting the output light pulses into the trigger pulses; and a bi-stable multivibrator, installed on the side of the (particle-accelerator) high voltage, which is activated by the trigger pulses. By means of the output of this bistable multivibrator, the particle beam of a particle accelerator is pulsed. (NSA of Japan)

19143 METHOD FOR INJECTING ELECTRONS INTO THE BETATRON CIRCULAR TUBE. Hattori, Hiroyuki (to Shimadzu Seisakusho Ltd.). Japanese Patent 1966-8640. May 6, 1966. Filed Mar. 23, 1963.

A method is proposed in which the number of electrons per injection having energies, enabling orbit entrance, can be increased without increasing the exciting frequency for the (betatron) magnetic poles, thereby increasing the x-ray output of the betatron. To increase the number of electrons per injection having sufficient energies for orbit entrance, a high-frequency oscillatory pulse with a frequency over several hundred kilocycles is added to the injection primary pulse. (NSA of Japan)

19144 PARTICLE ACCELERATOR. Kamokawa, Hiroshi; Adachi, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9752. May 25, 1966. Filed June 11, 1965.

In the particle accelerator proposed, the insulated transformer is installed within the evacuated chamber where the particles are accelerated, thereby giving a particle accelerator which is excellently insulated and is compact in shape. It consists of the following: the (outer) insulating cylindrical body; the upper disc fixed air-tight at the middle of the cylindrical body; the lower disc at earth potential fixed at the bottom end of the cylindrical body; the evacuated chamber formed by the cylindrical body and the two discs; the series of accelerating electrodes installed in the chamber; the insulated transformer installed in the chamber (supported on the lower disc), whose secondary winding is led out through the upper disc; the particle source installed at the upper end of the series of electrodes; the target located at the other end of the series; and a device for evacuating the (evacuated) chamber. (NSA of Japan)

19145 PARTICLE ACCELERATOR. Akatsu, Kaoru; Suganomata, Shinji (to Hitachi, Ltd.). Japanese Patent 1966-7758. Apr. 19, 1966. Filed Oct. 12, 1964.

A particle accelerator is described in which the ion beam is produced only when required, and is completely stopped when it is not used. This is accomplished by changing the polarity of the anode power source for impressing the ion source. It consists of the following: the ion source installed within the high-voltage electrode in the axis of the accelerating tube; the anode (ion source) to inject the ions from the ion source; the flange located between the accelerating tube and the ion source; and the switch for changing the polarity of the voltage applied to the anode and to the flange. (NSA of Japan)

19146 PARTICLE ACCELERATOR CONTAINING ITS POWER SOURCE. Adachi, Takeshi (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9750. May 25, 1966. Filed June 11, 1965.

In the particle accelerator proposed, containing its power

source, the high-voltage power source is located within the evacuated chamber where the accelerating tube is installed. It consists of the following: the evacuated insulating chamber (cylindrical body), closed air-tight at one end and at the middle; the accelerating tube contained in the evacuated chamber; the insulated, high dc voltage generator, installed in the same chamber; the particle source (connecting to the accelerating tube), installed just outside the air-tight end (at the middle of the evacuated chamber), which is actuated by means of the d.c. voltage generator; and a device for evacuating the (said) chamber. (NSA of Japan)

19147 CHARGED-PARTICLE ACCELERATOR. **Adachi, Takeshi** (to Tokyo Shibaura Electric Co., Ltd.). Japanese Patent 1966-9751. May 25, 1966. Filed June 11, 1965.

In the charged-particle accelerator proposed, the comparatively small high voltage source is installed in the evacuated chamber together with the series of accelerating electrodes. It consists of the following: the particle source; the series of accelerating electrodes for accelerating the injected charged particles; the target impinged upon by the accelerated charged particles; the Cockcroft high voltage-source circuits, which consist of a series of condensers (each one is located between the two accelerating electrodes), another series of condensers to one end of which high-frequency high voltage is applied, and a group of rectifier elements located between the two series of condensers; and the evacuated chamber in which the series of accelerating electrodes and the Cockcroft high voltage source circuits are contained. (NSA of Japan)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 18587, 18805, and 18833.

19148 (IN-1065) PREPARATION OF H_2O AND D_2O SLOW NEUTRON SCATTERING KERNELS FOR ENDF USING MR TYPE MODELS. McMurry, H. L.; Gannon, L. J. (Idaho Nuclear Corp., Idaho Falls). Mar. 1967. Contract AT(10-1)-1230. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The way in which slow neutron scattering kernels are being prepared for the Evaluated Nuclear Data File (ENDF) at Brookhaven National Laboratory using calculations based on models for the structure of liquid H_2O and D_2O at several temperatures is described. The models for H_2O at elevated temperatures are simple modifications of the MR (McMurry–Russell) model for 22°C water which gives computed scattering in agreement with Brugger's MTR data. The models for D_2O are obtained by scaling the MR model to correspond with using the mass of the D atom in describing the vibrational frequencies and modes in D_2O. For each temperature parameters have been adjusted to optimize agreement with available data. The data calculated for ENDF are obtained directly from calculations using the models, except in regions where the $S(\kappa^2,\beta)$ vs β functions show sharp spikes due to transitions associated with the characteristic vibrations present in the models. This structure may not be realistic, and may present problems of interpolation in the use of the ENDF data. Therefore, a procedure for calculating smoothed $S(\kappa^2,\beta)$ data in such regions is described. (auth)

19149 (JINR-P4-3158) NEKOGERENTNOE RASSEYANIE MEDLENNYKH NEITRONOV V POLYARIZOVANNOI MISHENI. (Incoherent Scattering of Slow Neutrons in Polarized Target). Baryshevskii, V. G.; Lyuboshits, V. L.; Podgoretskii, M. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of High Energy). 1967. 8p. (In Russian). Dep. mn.

Transmission of polarized slow neutrons through a polarized crystal target is considered. It is shown that incoherent neutron scattering in such a model is due not only to the scattering with spin flip but also to the presence of fluctuations of a magnetic quantum nucleus number. The relative deposit of these processes depends on the angles between the direction of neutron polarization and that characterizing the polarization target state. (auth)

19150 (KFK-457) PRINCIPALS AND PROBLEMS IN NEUTRON NUCLEAR DATA EVALUATION. Schmidt, J. J. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Oct. 1966. 20p. (CONF-661014-48). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

Some of the main physical problems encountered in the preparation of evaluated neutron cross sections are described. The difficulties involved in systematizing and automatizing the evaluation process are discussed. Examples are given which demonstrate some of the problems involved in this kind of data processing. (S.F.L.)

19151 (NAA-SR-Memo-12315) THE ATOMICS INTERNATIONAL EVALUATED NUCLEAR DATA FILES AND ASSOCIATED COMPUTER PROGRAMS FOR THE AUTOMATED PREPARATION OF MULTIGROUP CONSTANTS. Alter, H. (Atomics International, Canoga Park, Calif.). Feb. 24, 1967. Contract AT(04-3)-701. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Input data from the Atomics International Evaluated Nuclear Data File (AIENDF) tape are processed to give spectrum-weighted group-averaged neutron cross sections and other quantities required for the solution of the neutron transport equation by multigroup diffusion and transport theory methods. The calculation of multigroup Doppler-broadened effective resonance integrals and cross sections in the resonance region for a heterogeneous or homogeneous resonance absorber is based on the single-level Breit–Wigner theory with no overlapping of neighboring resonances. Inelastic and elastic scattering transfer matrices are calculated using differential scattering cross section data stored on the AIENDF Angular Distribution Data Tape (ADDT). Multigroup libraries are punched in any of the formats required by the one-dimensional multigroup diffusion theory codes, ULCER, FAIM, FAIM-CELL, CAESAR, and CAESAR IV; the one-dimensional multigroup S_n transport theory code, DTF; and the spectrum codes, FORM and AILMOE. (auth)

19152 (TID-23685) LINEAR ACCELERATOR PROJECT. Progress Report, October 1966–December 1966. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Engineering and Science). Contract AT(30-3)-328. 125p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Research on fast-neutron spectra continued with studies of electron beam targets for neutron sources and of the efficiency of proton-recoil detectors for spectral measurements. Computer programs were also written for the calculation of fast-neutron spectra. Neutron capture yields were measured for Al, Fe, Ni, and and Na; and neutron resonance scattering by ^{104}Rh at low energy was investigated. Neutron resonance capture in Fe and Ni was studied using a self-indication detection method. The development of a spark chamber for detecting ^{233}U fission fragments continued with emphasis on a different configuration. Measurements were also made of the spatial distribution of 4.9-eV neutrons in light water, time-dependent neutron spectra in light water, and time-dependent spectra as functions of material, buckling, absorption, and temperature; and a dual-disk neutron chopper with pulse widths of 1.8 and 3.6 μsec (full width at half maximum) was designed. Differential cross sections for neutron scattering by polyethylene at 0.33, 0.65, and 1.02 eV were measured. The research on transient radiation effects in Si irradiated with 50-MeV electrons was completed, and the effects of 48-MeV electrons on heavily doped Si were investigated. (D.C.W.)

19153 (ORNL-tr-1378) NIOBE COMPUTER PROGRAM DESCRIPTION AND USE. Brandicourt, Gilles; Culambourg, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by Gregory L. Boisvert (Oak Ridge National Lab., Tenn.), from report CEA-N-583. 65p. Dep. mn. JCL $5.60 fs, $1.85 mf.

A description is given of the NIOBE (Numerical Integration of Boltzmann Equation) computer program which gives a numerical solution of the neutron transfer equation in spherical geometry. Examples of using the code for several calculations are included. (S.F L.)

19154 NEUTRON DIFFUSION IN A MEDIUM CONSTITUTING OF TWO LOOSELY COUPLED CORES. Belleni-Morante, Aldo (CNR, Rome). Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 40: 80-6(Jan. 1966). (In Italian).

The neutron diffusion equations for a reactor that comprises two loosely coupled cores are derived directly from the transport equation. (D.C.W.)

19155 NEUTRON FLUX DISTRIBUTION FROM A 14 MeV NEUTRON GENERATOR. Priest, H. F.; Burns, F. C.; Priest, G. L. (Army Materials Research Agency, Watertown, Mass.). Nucl. Instrum. Methods, 50: 141-6(1967).

In order to carry out accurate activation analyses using a neutron generator employing the $^3H(d,n)^4He$ reaction, it is important to know the neutron flux distribution relative to the tritium target. Methods were developed for determining this flux distribution and typical examples are presented. (auth)

19156 QUASI-ELASTIC SCATTERING OF NEUTRONS BY DILUTE POLYMER SOLUTIONS. I. FREE-DRAINING LIMIT. de Gennes, P. G. (Univ., Paris, Orsay, France). Physics, 3: No. 1, 37-45(Jan. 1967).

In the so-called "free-draining limit", successive units of a long molecule equalize their average orientation by a diffusion process along the chain. For low values of the momentum transfer $\hbar q$ and of the energy transfer $\hbar\omega$ the dynamical form factor $S(q\omega)$ for neutron scattering is controlled by this effect, and is independent of the vibrational spectrum. In this regime, it is shown that the frequency width $\Delta\omega_q$ of $S(q\omega)$ is small and proportional to q^4. The unusual q^4 law is related to the fact that, in a time t, a signal travels a distance $d \sim \sqrt{t}$ along the chain, but the corresponding distance in space is only of order $d^{\frac{1}{2}}$ for a coiled polymer. On the other hand, if the chain is stretched this argument breaks down and the width $\Delta\omega_q$ for coherent scattering is predicted to increase. (auth)

19157 THEORY OF NEUTRON SCATTERING FROM LIQUID AND SOLID HYDROGEN. Elliott, R. J.; Hartmann, W. M. (Oxford Univ.). Proc. Phys. Soc. (London), 90: 671-80(Mar. 1967).

The inelastic spectrum of cold neutrons scattered incoherently from condensed hydrogen shows a quasi-elastic peak and an ortho-para conversion peak. A theory is developed to calculate the broadening of these peaks due to the hindering of the rotation of ortho-hydrogen molecules by anisotropic intermolecular interactions. The quadrupole–quadrupole, van der Waals, and valence interactions are taken between pairs of molecules; and contributions to the broadening up to the first power of the ortho concentration are discussed. The quadrupole–quadrupole term is seen to be dominant, broadening the ortho-para peak in agree-

ment with experiment but contributing a width to the quasi-elastic peak which is less than the resolution broadening. The theory is extended to the analogous incoherent scattering peaks in deuterium with similar results. (auth)

19158 ANALYTICAL METHOD FOR HANDLING THE ENERGY-DEPENDENT THREE-DIMENSIONAL BOLTZMANN EQUATION. Seebacher, G. (Univ., Graz). Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., 174: 99-115(1965). (In German).

An analytical method for solving the three-dimensional, energy-dependent Boltzmann equation is proposed. It is shown that the cylindrical (e.g., circular) symmetry problem can be reduced to a plane problem to which the Muskelishvili method for solving singular integral equations applies. The approximation method is also discussed. (G.O.Y.)

19159 TREATMENT OF THE PLANE ENERGY-DEPENDENT NEUTRON TRANSPORT PROBLEM BY USING THE PARTICULAR SOLUTIONS OF THE NEUTRON TRANSPORT EQUATION. Collatz, S. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 329-33(Nov. 1966). (In German).

The solution given in a previous paper for the energy-dependent plane neutron transport problem of a bare slab on the basis of particular solutions of the neutron transport equation is shown to be applicable for all one-dimensional problems with layers not too thin. Moreover, an iteration method for solving the integral equation of the Fredholm type occurring in the calculations is discussed. (auth)

19160 THE VARIATION OF THE SPECTRUM OF 14-MeV NEUTRONS PASSING THROUGH DIFFERENT SHIELDINGS. Angeli, Istvan; Hunyadi, Ilona. ATOMKI (At. Kut. Intez.) Kozlem., 8: 340-3(Dec. 1966). (In Hungarian).

Measurements of the variation in the spectrum of 14-MeV neutrons were made in transmission through paraffin and iron-containing concrete shields of 20- and 40-cm thickness. (auth)

19161 RADIATIVE TRANSFER PROBLEMS IN PLANE GEOMETRY. Siewert, Charles Edward. Ann Arbor, Mich., Univ. of Michigan, 1965. 123p.

Thesis.

Case's method of singular normal modes is used to obtain an exact solution to the equations of radiative transfer in the Uniform Picket Fence model, assuming Local Thermodynamic Equilibrium. Completeness and orthogonality theorems are proved; and explicit results are obtained for the extrapolated endpoint, the temperature distribution, and law of darkening for the Milne problem. In addition, the method for solving other half-space problems is sketched. The case when the determinant of the "transfer matrix" does not vanish (corresponding to radiative transfer without complete Local Thermodynamic Equilibrium or the neutron transport problem) also is discussed. Full-range completeness and orthogonality theorems are presented for this case; however, no convenient form for the half-range case was found. By allowing the absorption coefficient for the radiation to take N values, the Generalized Picket Fence model is formulated. Again, Case's method is used to construct the eigensolutions of the resulting matrix transport equation. These normal modes are shown to obey half-range completeness and orthogonality theorems. The Milne problem is solved, and explicit results are obtained for the extrapolated endpoint and the law of darkening. Implicitly the complete solution is presented. (Diss. Abstr.)

19162 INELASTIC NEUTRON SCATTERING FROM PRESSURIZED ETHANE. Straker, Edward Albert. Ann Arbor, Mich., Univ. of Michigan, 1965. 104p.

Thesis.

Motions of the ethane molecule were investigated at room temperature by inelastic neutron scattering techniques. It was of particular interest to determine if the torsional motion of the CH_3 groups could be observed by neutron interaction, to investigate the effect on the molecular motions of condensing the gas by pressurization, to determine the importance of multiple neutron scattering for the data obtained, and to determine if the data could be reasonably predicted by a theoretical model. To obtain the inelastic neutron scattering data, both a triple-axis crystal spectrometer and a four-rotor mechanical monochromator were used. To investigate the torsional motion, data were obtained at scattering angles of 90 and 22°. Gaseous and liquid ethane, maximum density change of a factor of 48, were investigated at a scattering angle of 90° for several neutron energies. Several target thicknesses were observed at both large and small scattering angles to determine the importance of multiple scattering. Thin target data were obtained for neutron energies from 0.020 to 0.064 eV. Contributions from excitation of the torsional motion are evident in the low-energy, forward angle data. The data indicate that the first energy level of the torsional oscillator is approximately 0.034 eV in good agreement with specific heat results. There is no significant difference in the data for gaseous and liquid ethane indicating that molecular rotations are not significantly influenced by condensation. Distortion due to multiple scattering is noted in the data for targets with transmissions less than 75%. Thin target data are approximately predicted by a theoretical model with a quasi-classical treatment of rotations, an ideal gas representation of translations, a harmonic oscillator description of the torsional motion, and a low-temperature treatment of other vibrations. The major limitations of the theoretical analysis are discussed. (Diss. Abstr.)

19163 NEUTRON SCATTERING IN STRETCH-ORIENTED POLYETHYLENE. Myers, William Roger. Ann Arbor, Mich., Univ. of Michigan, 1965. 119p.

Thesis.

Previous measurements on polyethylene have not succeeded in defining the location of the upper frequency limit of the skeletal stretch-bend vibrational mode. Neutron scattering experiments have been able to locate the event crudely in the range 500 to 600 cm^{-1}; and theoretical calculations variously place it at 500, 530, and 540 cm^{-1}. By employing a variation of the Brockhouse constant-Q technique, applying it to the measurement of incoherent neutron scattering cross sections, it is possible to separate modes of different polarization. Suppression of modes polarized transversely to the molecular axis enables the stretch-bend limit to be seen clearly at 525 ± 15 cm^{-1}. The neutron scattering cross section for a single crystal of arbitrary symmetry is derived following established procedures. The incoherent cross section is discussed in terms of the phonon frequency spectrum of the lattice and orientation averages are calculated for uniaxially and randomly oriented targets. It is shown that the incoherent scattering cross section does not, in general, determine the true frequency spectrum, but an amplitude-weighted directional spectrum. Transverse and longitudinal cross sections are defined for uniaxially oriented targets, and it is shown how these may be measured on a triple-axis crystal spectrometer. It is demonstrated that stretching polyethylene gives it a high degree of uniaxial orientation with the molecules lined up along the stretching direction. The transverse and longitudinal cross sections are measured at 93°K for analyzer energies of 30 and 34 MeV. An event is seen clearly at 65 MeV (525 cm^{-1}) energy transfer in the longitudinal data which is not indicated in the transverse; it is therefore assigned to the upper frequency limit of the stretch-bend mode. The nominally transverse torsional mode with frequency limit near 25 MeV (200 cm^{-1}) is unexpectedly strong in the longitudinal spectrum. Observed singularities confirm results of earlier measurements on polycrystalline polyethylene. It is possible to make tentative statements about the polarization of some of the fine structure, although it is rather weak. (Diss. Abstr.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 19018, 19174, and 19299.

19164 (AECD-TP-16) BOUND STATE EIGENVALUE PROGRAMME FOR REAL POTENTIALS. Ali, Shamsher; Islam, Mazharul (Atomic Energy Centre, Dacca (Pakistan)). Sept. 1966. 12p. Dep. mn.

A program is proposed to seek solutions for the radial Schroedinger equation of a bound system of two particles for real and central potentials. The program given provides various quantities of interest for such a system. Included in these quantities are binding energy, wave functions at various distances, root-mean square separation, and expectation values of the kinetic and potential energies. (J.F.P.)

19165 PROGRAMME FOR THE STUDY OF FINAL STATE INTERACTIONS IN THE DECAY OF LIGHT HYPERNUCLEI. Vilain, P.; Wilquet, G. (Institut Interuniversitaire des Sciences Nucleaires, Brussels). Univ. Brux., Inst. Phys., Bull., No. 30, 1-22; A1-47(Nov. 1966).

A description is given of a computer code for calculating the kinematical quantities relevant to the study of final-state interactions between the decay products of light hypernuclei. The program is designed to analyze all types of events in which final state interactions can be studied experimentally with presently available statistics. The program is written in FORTRAN IV for the IBM 7040 computer. (S.F.L.)

19166 PARTICLE-HOLE STATES IN THE ALPHA PARTICLE WITH REALISTIC FORCES. Barrett, B. R. (Stanford Univ., Calif.). Phys. Rev., 154: 955-70(Feb. 20, 1967).

The Tamm-Dancoff equations are solved, using the realistic separable potential of Tabakin, for the odd-parity excited states of ^{4}He. A comparison is made with results obtained using the hard-core potentials of Brueckner, Gammel, and Thaler and of Hamada. The calculated spectrum is found to be strongly influenced by the p-state contributions, particularly by the effect of the tensor interaction. It is predicted that the 0^-, T = 0 state lies close to the 2^-, T = 0 state. The spin-orbit splitting between the $p_{\frac{1}{2}}$ and $p_{\frac{3}{2}}$ single-particle states is calculated and is found in first order to depend only on the relative two-body spin-orbit interaction. An estimate for the ratio of the probability of an E1 transition from the upper 1^-, T = 1 state to the ground state to that of an E1 transition from the lower 1^-, T = 1 state is calculated to be 1.6, compared with the experimental ratio which is $\sim\frac{1}{2}$. The squared matrix elements and the total capture rate for muon capture in ^{4}He are also captured. The squared matrix elements are found to be equal within 10 percent, but the calculated total capture rate is smaller than the experimental rate. The theoretical results tend to justify the use of the supermultiplet theory for the excited states of the α particle. It is found that the seven equations obtained for the energy splittings depend upon only four quantities. Consequently, three relations, which give the two unobserved energy splittings and the ratio of the E1 transition probabilities in terms of the four observed energy splittings, are obtained. The two empirical results which can be compared with experiment are in excellent agreement. (auth)

19167 TENSOR FORCE AND ZERO-ENERGY n-d SCATTERING. Mitra, A. N. (Delhi Univ.); Schrenk, G. L.; Bhasin, V. S. Ann. Phys. (N. Y.), 40: 357-73(Dec. 1966).

A three-body formalism with separable potentials is developed, with the inclusion of tensor forces in addition to the usual s-wave forces in triplet and singlet N-N states. For completeness, the formalism is generalized to include the effect of a hard core term in the singlet s-state, which is shown to require an extra spectator function, over and above three others already associated with the tensor and s-wave forces. Numerical results are presented for the doublet n-d scattering length, which, unlike its quartet counterpart, is rather sensitive to variations in the two-body potential parameters. While it has not yet been possible to obtain a quantitative estimate of the hard-core effect (because of the enormous computational problems associated with four spectators) the effect of the tensor force has been investigated in some detail with several sets of input parameters as are currently available. It is found that while the inclusion of tensor force greatly improves the magnitude of the scattering length, its sign is still negative, contrary to the experimental situation. The assumption of a smaller magnitude for the (negative) n-n scattering length, than its charge-independent value, (for which there is some recent evidence), yields a further improvement in the value of $a_{\frac{1}{2}}$, but not enough to flip its sign. This discrepancy is briefly discussed in the context of similar results obtained by other authors. (auth)

19168 SEARCH FOR A ^{4}Li STATE AT 10.6 MeV IN THE ELASTIC SCATTERING OF PROTONS BY ^{3}He. Igo, G. J.; Leland, W. T. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 154: 950-4(Feb. 20, 1967). (LA-DC-7493(Rev.)).

Elastic p-^{3}He scattering was measured in an attempt to obtain further information regarding the possible existence of a state in ^{4}Li near 10.6 MeV of width ≤400 keV, which has been inferred from observations of $_\Lambda$He^4 decay. In view of the possibly very small width of the state, experimental details were arranged to permit observation associated with widths as small as 25 keV. Differential elastic-scattering cross sections were measured at cms angles of 70.9, 91.1, 104.4, and 112.0° and over a laboratory energy range of 11.6 to 16.4 MeV in 25-keV steps. The measured cross sections decreased slowly with increasing energy, and no evidence of a resonance was observed. Therefore, it is concluded that if a 1^- state in ^{4}Li near 10.6 MeV decays predominantly in the p-^{3}He channel, the width of the state must be less than 25 keV. (auth)

19169 DEUTERON ELASTIC SCATTERING FROM ^{3}He AND ^{3}H. Tombrello, T. A.; Spiger, R. J.; Bacher, A. D. (California Inst. of Tech., Pasadena). Phys. Rev., 154: 935-40(Feb. 20, 1967).

The elastic scattering of deuterons from ^{3}He and ^{3}H was studied for bombarding energies up to 11 MeV. The excitation curves obtained show a broad resonance in the scattering cross section corresponding to an excitation energy of 20 ± 0.5 MeV in both ^{5}He and ^{5}Li. These data, together with ^{3}H(d,n)^{4}He and ^{3}He(d,p)^{4}He data from other sources, tend to indicate that D waves are responsible for the anomaly. (auth)

19170 PHOTODISINTEGRATION OF THE DEUTERON BY POLARIZED GAMMA RAYS. Barbiellini, G.; Bernardini, C.; Felicetti, F.; Murtas, G. P. (CNEN, Frascati, Italy). Phys. Rev., 154: 988-93(Feb. 20, 1967). (LNF-66/35).

An experiment was performed on the photodisintegration of the deuteron by linearly polarized γ rays in the energy range from 200 to 400 MeV. The polarization is obtained by the crystal technique and is generally of the order of 30 to 40%. Both the neutron and the proton are detected in coincidence in order to reduce the background drastically. The asymmetry parameter at 90° in the cms system was determined as a function of the energy k of the photon; it depends very little on k and has a value close to −0.3 all over the range. (auth)

19171 PHOTODISINTEGRATION OF ^{3}He. Stewart, James Russell. New Haven, Yale Univ., 1965. 128p.

Thesis.

The differential cross section at 90° in the laboratory system for the ^{3}He(γ,d)p reaction was measured from 8.5 to 46 MeV gamma energy using bremsstrahlung from the Yale electron linear accelerator. A magnetic quadrupole triplet lens system was used with silicon detectors. The absolute cross section was obtained by comparison with the ^{2}H(γ,p)n reaction. The ^{3}He cross section result has a broad peak with a maximum of 90 ± 8 μb/Sr at 10 to 12 MeV gamma energy. This result is compared with the results of other experiments and theoretical calculations. The proton energy spectrum at 90° in the laboratory system from the ^{3}He(γ,2p)n reaction was also observed. Using a number of assumptions, this spectrum is compared with the results of other experiments and theoretical calculations. A brief discussion of the nuclear radius of ^{3}He is included. (Dissertation Abstr.)

19172 NEUTRON ENERGY AND ANGULAR DISTRIBUTION MEASUREMENTS FROM THE REACTION d(p,n)2p AT 45.5 MeV. Margaziotis, Demetrius John. Los Angeles, Univ. of California, 1966. 90p.

Thesis.

A measurement was made of the differential cross section $d\sigma/d\Omega$ of the reaction d(p,n)2p at 45.5 MeV, for angles between 5 and 35° in the laboratory system in steps of 5°. This was accomplished by measuring the energy distribution $d\sigma/d\Omega dE$ of the neutrons produced in this reaction at each angle. The differential cross section $d\sigma/d\Omega$ was obtained from $d\sigma/d\Omega dE$ by integration over an energy interval extending from the maximum neutron energy down to an energy corresponding to a relative energy E_{pp} = 8 MeV between the two protons in the final state. A neutron spectrometer was developed for this purpose. This is a two-counter telescope. Each detector consists of a 1.90-cm-thick NE 102 plastic scintillator. An incident neutron produces a recoil proton in the radiator. The stopping counter detects only forward recoil protons. The sum of the pulses produced by such a proton in passing through the two detectors determines the energy of the neutron. The electronics performing the pulse height analysis are gated by a fast coincidence (2τ = 8 nanoseconds) between the two counters. Thus only pulse pairs belonging to a given neutron are processed. This reduces pile-up effects. The two outputs are displayed on a 64 × 64 two-dimensional analyzer. Neutrons of a given energy lie on a 45° line on this display. The energy threshold of the spectrometer is 7 MeV, and its efficiency is 1.1×10^{-4} at 50 MeV. The calculated resolution at 50 MeV is 4.7%. The telescope is mounted on a scattering stand and can be brought to within 15 cm of a target. A deuterated polyethylene target was used for the neutron measurements. Background was determined by bombarding an equally thick ordinary polyethylene target. The deuterium present in the target was monitored through p-d elastic scattering. A separate measurement of $d\sigma/d\Omega$ for p-d elastic scattering at 45.5 MeV was made for 30, 55, and 60° in the laboratory system. The neutron spectra measured show a peak at the maximum energy. This is due to the final state interaction of the two protons. This peak shows a broadening with increasing angle. No peaking is observed for angles larger than 35°. The cross section $d\sigma/d\Omega$ decreases with angle. The experimental values are compared with theoretical calculations of Castillejo and Singh based on the impulse approximation. (Dissertation Abstr.)

19173 DIFFERENTIAL CROSS SECTION OF 40-MeV NEUTRONS SCATTERED FROM PROTONS. Tagliaferri, Edward Jr. Los Angeles, Univ. of California, 1966. 128p.

Thesis.

The purpose of the experiment was to measure the differential cross section of 40-MeV neutrons scattered from protons. The neutrons were produced by inserting a hollow probe cooled with D_2O into the circulating proton beam of the UCLA 50-MeV cyclotron. The neutrons from the deuteron break-up in the heavy water were collimated into a beam and scattered from protons in a piece of plastic scintillator. The recoil proton was detected in this scintillator, in coincidence with the scattered neutron, which was detected by another scintillation counter placed at the desired scattering angle. The energy of the scattered neutron was determined by measuring its time-of-flight from the target to the neutron detector. Four neutron detectors were used simultaneously

during the experiment, with anti-coincidence scintillation counters placed in front of each one to prevent charged particles originating in the target counter from registering as valid scattering events. One counter remained at 25° to the neutron beam throughout the experiment to continuously monitor the energy and intensity of the incident neutrons. Two corrections were made to the results. The data taken at 40° in the center of mass had to be adjusted upward by 33.2% because part of the pulse-height spectrum of the recoil protons from neutrons scattered at this angle was cut off by the discriminator on the target counter. The second correction was a downward adjustment of the data at center of mass scattering angles from 90 to 140°. This correction had to be made because at these angles, it was energetically possible for an incident neutron to cause the break-up of a carbon nucleus in the target counter into three detectable α particles and still have enough energy left over so that its velocity was the same as it would have been had it scattered from a proton. The corrections increased in size with increasing scattering angle, ranging from 1.7 ± 0.3% at 90° to 29 ± 7% at 140°. The corrected data were normalized to the differential scattering cross section measured by the Harwell group with 42.5-MeV neutrons. The normalized data from the three neutron detectors were then averaged. The average data were fitted by the method of least squares to a polynomial of the form $d\sigma/d\Omega = a_0 + a_1 \cos\theta + a_2 \cos^2\theta$ where θ is the neutron scattering angle. The values obtained for a_0, a_1, and a_2 were 13.04 ± 0.38, −2.98 ± 1.15, and 7.11 ± 1.62, respectively. The corresponding coefficients for a similar fit made to the data taken by the Harwell group are 14.20 ± 0.28, 0.16 ± 0.49, and 4.49 ± 0.73. (Dissertation Abstr.)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 17886, 19018, 19164, 19208, 19218, 19222, 19292, 19296, 19299, and 19324.

19174 (BNL–11035) NUCLEAR STRUCTURE PHYSICS USING 1-GeV PROTONS. Friedes, J. L. (Brookhaven National Lab., Upton, N. Y.). Feb. 6, 1967. Contract AT(30-2)-Gen-16. 33p. (CONF-670109–1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Annual Meeting of the American Physical Society, New York.

Details of the experimental apparatus and some results of preliminary measurements are given for nuclear physics experiments using 1-GeV protons from the Brookhaven Cosmotron. Descriptions are given of the spectrometers; the beam transport system; the target and target stand; and the wire spark chamber system. Preliminary results are given on elastic scattering of 1-GeV protons from H and ^{16}O, and for scattering of 2-GeV protons from D. (S.F.L.)

19175 (LAL–1165) ELECTRON SCATTERING FROM ^{9}Be. Bernheim, M.; Stovall, T.; Vinciguerra, D. (Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire). Jan. 1967. 43p. Dep. mn.

Form factors for electron elastic and inelastic scattering by ^{9}Be at 340 MeV were measured. The results were analyzed using several nuclear models. Values for the nuclear charge radius and quadrupole moment of ^{9}Be were obtained. (D.C.W.)

19176 LIFETIME MEASUREMENTS IN ^{14}N. Lieb, K. P.; Hartmann, R. (Univ., Freiburg i. B.). Z. Phys., 200: 432-43 (Mar. 14, 1967). (In German).

The Doppler Shift Attenuation Method was used to measure the lifetimes of the four lowest negative parity states in ^{14}N. The states were produced in the reaction $^{12}C(^{3}He,p)^{14}N$ and were found to have mean lifetimes

State (MeV)	lifetime (ps)
4.91	$\tau < 0.050$
5.10	$4.5 < \tau < 20$
5.69	$\tau \leq 0.036$
5.83	$\tau > 4.5$

The results obtained are compared with the predictions of the nuclear shell model. (tr-auth)

19177 THREE-BODY MODEL FOR ^{6}He. Hebach, H.; Henneberg, P.; Kuemmel, H. (Max Planck-Institut fuer Chemie, Mainz). Phys. Lett., 24B: 134-6(Feb. 6, 1967).

Using separable potentials in a three-body Schrödinger equation the ground state binding energy of ^{6}He is calculated in good agreement with the experimental value. (auth)

19178 THE ELASTIC SCATTERING OF 20.1 TO 23.3 MeV α PARTICLES BY ^{14}N. Bolta, J. M. (Instituto de Fisica Corpuscular, Valencia); Garcia, A.; Senent, F.; England, J. B. A. An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 35-40 (Jan.-Feb. 1967).

Experimental results for the elastic scattering of 20.1 to 23.3 MeV α particles by nitrogen are presented. Differential cross-sections were calculated within the angular interval from 10 to 170° (lab. system); the backward-angle scattering is especially investigated and discussed. (auth)

19179 ISOBARIC SPIN MIXING IN THE ^{8}Be 16.62 AND 16.92 MeV STATES. Hohloch, E.; Wildermuth, K. (Univ., Tuebingen, Ger.). Phys. Lett., 24B: 121-3(Feb. 6, 1967).

The 16.62 and 16.92 MeV levels of ^{8}Be are considered, and it is found from theoretical calculations that it is impossible to make a pure isospin assignment to either of these levels. This is in agreement with various experimental data. (auth)

19180 THE REACTION $^{16}O(n,\alpha)^{13}C$ AT A NEUTRON ENERGY OF 14 MeV. Fuerst, M.; Muenzer, H. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., 174: 187-99(1965). (In German).

A vanadium pentoxide layer on gold foil was used as the target to investigate the reaction $^{16}O(n,\alpha)^{13}C$ at 14 MeV. The pickup as well as the knock-on processes were studied. The angular distributions of the α particles were determined and were compared with similar results obtained in nuclear emulsions. The excitation energy of the rest nuclei was calculated. From the energy and angular distributions measured, the levels of the ^{13}C nucleus were deduced. The cross sections for the reaction were also calculated; the (n,α) cross section was 0.5 mbarns. (G.O.Y.)

19181 MEASUREMENT OF THE MEAN LIFE OF THE 3.085-MeV LEVEL OF ^{13}C. Mennrath, P.; Hubert, Ph.; Leccia, F.; Thibaud, J. P. Phys. Lett., 24B: 285-7(Mar. 20, 1967). (In French).

The mean life of the 3.085-MeV level of ^{13}C was measured using a method based on the Doppler effect. (D.C.W.)

19182 STUDY OF THE 9485, 9490, 9613, AND 9670 keV EXCITED STATES IN ^{15}O. Lambert, M.; Durand, M. (Institut d'Etudes Nucleaires, Algiers). Phys. Lett., 24B: 287-90 (Mar. 20, 1967).

Proton elastic scattering by ^{14}N was studied in the region E_p = 1.9 to 3.0 MeV. Four resonances were observed at E_p = 2343 ± 4, 2347 ± 40, 2479 ± 6 and 2547 ± 6 keV, with widths of Γ = 7 ± 2, 300 ± 30, 7 ± 2 and 2 ± 1 keV, and J^{π} values of $5/2^-$, $3/2^+$, $3/2^-$, and $(1/2, 5/2)^-$, corresponding to excited states in ^{15}O at E_x = 9.485, 9.490, 9.613 and 9.670 MeV, respectively. (auth)

19183 CONTRIBUTION OF THE (n,2n) AND (n,α) EFFECTS IN BERYLLIUM TO THE NEUTRON MULTIPLICATION COEFFICIENT. Krasin, A. K.; Plindov, H. I. Izv. Akad. Nauk BSSR, Ser. Fiz.-Tekh, Nauk, No. 1, 52-3(1965). (In Russian).

The effect of the reactions on the critical masses and dimensions of physical assemblies with beryllium moderator and reflector and the contribution of the fast effect to the multiplication coefficient were investigated. Ten-group constants were set up for beryllium. The (n,2n) reaction was regarded as inelastic scattering leading to the appearance of an additional neutron. The cross sections for the reactions were taken from the literature. To check on the constants, the age of the neutrons of the fission spectrum and the fast-neutron multiplication coefficient were determined for an infinite homogeneous beryllium medium. The value obtained for the neutron age (79 cm^2) agreed with the published data. The multiplication coefficient for fast neutrons was found to be 1.087, in good agreement with theoretical estimates. The data were used to determine the critical masses and the critical dimensions of some physical assemblies. The results are tabulated and show that the fast effect in beryllium is 9 to 10%. (ATD)

19184 INVESTIGATION OF THE PHOTODISINTEGRATION OF THE ^{16}O NUCLEUS. Komar, A. P.; Denisov, V. P.; Kul'chitskii, L. A. (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 169: 1307-10(Aug. 21, 1966). (In Russian).

Two problems of the photodisintegration of the ^{16}O nucleus were investigated: the transition probability of the final ^{15}N nucleus and the integral cross section of the γ quanta above the giant resonance range. This involved measurement of the energy spectra of the photoprotons of the (γ,p) reaction in the range of E_{max} = 21.3 to 55.0 MeV. The protons were recorded at an angle of 90° with respect to the bremsstrahlung. The measurements indicated that the integral cross section of the $(\gamma,p_{1,2})$ and (γ,p_3) reactions amounts to 7.5 ± 2.0 MeV-mb and 14.1 ± 2.2 MeV-mb, respectively. If the contribution of low-energy γ quanta is considered, a value of about 22 MeV-mb is obtained. It is thus shown that transitions to positive-parity levels (5.28 and 5.30 MeV) of the ^{15}N nucleus formed by the $^{16}O(\gamma,p)^{15}N$ reaction is comparable with the transition intensity to negative-parity levels. The integral cross

section was found to be 240 MeV-mb agreeing with the value predicted for the classical dipole sum, 60 NZ/A MeV-mb. Thus, more than half of the integral photoabsorption cross section of the ^{16}O nucleus lies at the range of high-energy γ quanta. (TTT)

19185 THE TOTAL CROSS SECTION OF THE $^{19}F(d,p)^{20}F$ REACTION FROM E_d = 400 TO 700 keV. Schlenk, Balint; Mesko, Laszlo. ATOMKI (At. Kut. Intez.) Kozlem., 8: 280-7(Dec. 1966). (In Hungarian).

The total cross section of the $^{19}F(d,p)^{20}F$ reaction was measured in the deuteron energy range of 400 to 700 keV by the activation method using a thin CaF_2 target. A GM counter with an end window built in a vacuum chamber was used for the measurement of the ^{20}F activity ($T_{\frac{1}{2}}$ = 10.7 sec). Four independent counters with an electronic GM impulse switching system were employed for the determination of the decay curve of the target activity. The results obtained in the lower deuteron energy region complete the data obtained by S.C. Snowdon. (auth)

19186 ISOMERIC STATES IN $^{7}_{\Lambda}He$. Dalitz, R. H. (Oxford Univ.); Gal, A. Nucl. Phys., B1: 1-6(1967).

The M1 amplitudes are calculated for transitions between $^{7}_{\Lambda}He$ states. If the spin-dependent part Δ of the ΛN central interactions exceeds 0.25 MeV, neither $(\frac{3}{2}^+)$ nor $(\frac{5}{2}^+)$ states of $^{7}_{\Lambda}He$ will be isomeric; for $\Delta < 0.12$ MeV, both states will be isomeric. For intermediate Δ, the isomeric state is the third state of $^{7}_{\Lambda}He$, with spin $(\frac{5}{2}^+)$. Angular correlation studies are proposed to determine the isomer spin directly. (auth)

19187 A STUDY OF THE STRUCTURE OF THE γ ABSORPTION CROSS SECTION OF ^{16}O AND ^{12}C NUCLEI IN THE REGION OF THE DIPOLE GIANT RESONANCE BY AN ABSORPTION METHOD. Dolbilkin, B. S. Tr. Fiz. Inst., Akad. Nauk SSSR, 36: 18-83(1966). (In Russian).

The absorption cross section is determined by measuring the gamma attenuation after passage through an adsorber. The nuclear absorption cross section can be obtained after estimating the contributions from pair formation and Compton scattering. A pair spectrometer with a resolution of 110 keV at a gamma energy of 20 MeV and a slit width of 2 mm is used to take the readings. A nine-channel pair spectrometer improved the counting efficiency an order of magnitude over the single-channel pair spectrometer. The results represent the first, direct, reliable data on the structure of nuclear absorption cross sections. The following resonances were found in the absorption cross sections: at 17.2, 19.0, 19 4, 20.9, 22.3, 23.1, 24.3, 25.2, and 25.8 MeV for ^{16}O; and at 16.5, 17.6, 19.1, 23.0, and 25.6 MeV for ^{12}C. A comparison of theory with experiment shows that theory predicts a smaller number of transitions (five for ^{16}O and four for ^{12}C). The agreement of the position and number of maxima for ^{16}O in the absorption cross section and the (γ,p) and (γ,n) reaction cross sections can be considered as indirect evidence of the charge symmetry of nuclear forces. The radiation width of the ^{16}O states is 3 to 30% of the single-particle Weiskopf width, which is in agreement with shell-model predictions on the E1 transition probability. There is evidence that the large maximum in the ^{12}C absorption cross section at 20 to 24 MeV consists of a number of narrow unresolved peaks. (TTT)

19188 ENERGY-RANGE CURVE FOR ^{7}Li IONS IN AIR. Moesner, J.; Schmidt, G.; Schintlmeister, J. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Ann. Phys. (7), 18: 268-70(Nov, 1966). (In German).

The reaction $^{14}N(n,2\alpha)^{7}Li$ was investigated using a cloud chamber. The chamber was filled with air and water vapor. 1,127 events were measured. From the α tracks, the energy of the pertinent ^{7}Li track could be calculated by use of the well known energy-range curve for α particles and by use of the pulse law. For the energy range from 0.1 to 5.0 MeV, the mean ranges of ^{7}Li ions in dry air at 15°C and 760 torr were given. (tr-auth)

19189 EXCITED STATES OF THE ^{19}F NUCLEUS. Zaikin, D. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 36: 10-17(1966). (In Russian).

Calculations by the shell model or by the collective model satisfactorily describe the experimental data on the position of the low-lying levels and the probabilities of the E2 transitions in ^{19}F However, neither of these theoretical treatments can explain the large probability of the E3 transition between the $(\frac{1}{2}^+)$ ground state and the $(\frac{5}{2}^-)$ state at 1.35 MeV. The experimental probability is 12 ± 4 single-particle (Weiskopf) units, while the theoretical estimate is about one Weiskopf unit. The presence of a strong E3 transition indicates the existence of a large octupole deformation (static or dynamic) in the ^{19}F nucleus. It is shown mathematically with the use of the collective model that in order to explain the high probability of the E3 transition in the ^{19}F nucleus by the interaction of an odd proton with the octupole oscillations, it is necessary that the amplitude of the neutral oscillations be sufficiently large ($\alpha \cong 0.3$), that is, that the nucleus be sufficiently "soft" with respect to the octupole oscillations. The nearest magic nucleus ^{16}O is also "soft" with respect to octupole oscillations. (TTT)

19190 YIELDS OF SOME RECOIL-PROTON REACTIONS INITIATED IN BORON, CARBON, NITROGEN, AND OXYGEN BY 14.7-MeV NEUTRONS. Wilkniss, P. E. (Naval Propellant Plant, Indian Head, Md.). Radiochim. Acta, 6: 135-8(Dec. 1966).

Several recoil-proton reactions which occur in the 14.7-MeV neutron flux of a neutron generator were calculated and measured. Results were obtained for $^{12}C(p,\gamma)^{13}N$ and $^{13}C(p,n)^{13}N$ in naphthalene and polyethylene, for $^{16}O(p,\alpha)^{13}N$ and $^{18}O(p,n)^{18}F$ in water, for $^{14}N(p,\alpha)^{11}C$ and $^{14}N(p,n)^{14}O$ in hydrazine and for $^{11}B(p,n)^{11}C$ in lithium borohydride. (auth)

19191 STUDIES OF J DEPENDENCE IN NEUTRON PICKUP REACTIONS. Glashausser, C. (Princeton Univ., N. J.); Rickey, M. E. Phys. Rev., 154: 1033-49(Feb. 20, 1967).

The dependence of the form of angular distributions on the total angular momentum transfer (J dependence) was studied for the following reactions: $^{56}Fe(p,d)^{55}Fe$ at 18.5, 20.0, 22.4, 25.7, and 27.5 MeV; $^{58}Ni(p,d)^{57}Ni$ at 20.0, 25.4, and 27.5 MeV; $^{12}C(p,d)^{11}C$, $^{32}S(p,d)^{31}S$, and $^{208}Pb(p,d)^{207}Pb$ at about 28 MeV; and $^{56}Fe(^3He,\alpha)^{55}Fe$ at 30 and 40 MeV. Pronounced J dependence was found to persist for both l = 1 and l = 3 transfers in the $^{56}Fe(p,d)^{55}Fe$ and $^{58}Ni(p,d)^{57}Ni$ reactions over the entire energy range; changes with energy are gradual but definite. The spin dependence of l = 2 distributions in the $^{32}S(p,d)^{31}S$ reaction is equally striking, but essentially no J dependence was observed for either l = 1 or l = 3 transfer in the $^{208}Pb(p,d)^{207}Pb$ reaction. Apparent Q dependence makes the interpretation of the $^{12}C(p,d)^{11}C$ results ambiguous. The $^{56}Fe(^3He,\alpha)^{55}Fe$ reaction revealed small but noticeable phase differences between $\frac{5}{2}^-$ and $\frac{7}{2}^-$ distributions. Analysis of the $^{56}Fe(p,d)^{55}Fe$ distributions with the distorted-wave Born approximation was not successful in explaining the results. Finite-range nonlocal calculations including spin-orbit forces in both incoming and outgoing channels and/or modified neutron form factors predicted little J dependence. (auth)

19192 DISTORTED-WAVE BORN-APPROXIMATION ANALYSIS OF THE $(d,^3He)$ REACTION ON "CLOSED-SHELL" NUCLEI. Hiebert, J. C. (Texas A and M Univ., College Station); Newman, E.; Bassel, R. H. Phys. Rev., 154: 898-920(Feb. 20, 1967). (ORNL-P-2562).

Angular distributions for $^{16}O(d,^3He)^{15}N$ and $^{40}Ca(d,^3He)^{39}K$ reactions were measured at an energy of 34.4 MeV. The applicability of the distorted-wave theory to these reactions and the ability to exact reliable spectroscopic factors was investigated. Calculations using the local zero-range, nonlocal, and finite-range formulations are compared with the data. The roles of L · S coupling, deuteron optical-model parameters, and radial cutoffs on the predicted shape and magnitude are presented. The local zero-range and finite-range forms of the theory give comparable spectroscopic factors, while the nonlocal calculations are consistently low. Deviations from the closed-shell description of the ground states of ^{16}O and ^{40}Ca are observed. Substantially all the 1p hole strength in ^{16}O is found, and in ^{40}Ca some deeper l = 2 hole strength is seen. Results of $^{40}Ca(d,t)^{39}Ca$ reactions are also presented. (auth)

19193 EXCITATION FUNCTIONS FOR THE (π^-,π^-n) REACTION ON ^{12}C AND ^{19}F. Kaufman, Sheldon; Hower, Charles O. (Princeton Univ., Princeton, N. J.). Phys. Rev., 154: 924-7 Feb. 20, 1967. (PPAD-582E).

Cross sections for the reactions $^{12}C(\pi^-,\pi^-n)^{11}C$ and $^{19}F(\pi^-,\pi^-n)^{18}F$ were measured with incident pions of kinetic energy between 0.70 and 1.80 GeV. The results, together with earlier measurements of the former reaction, are compared with a simple model of (X,XN) reactions, assuming a clean knockout of a nucleon N by an incident particle X. It is shown that the model does not correctly predict the magnitude of the (π^-,π^-n) cross sections, although it is successful in predicting the general trend of cross section with energy. (auth)

19194 MANY-NUCLEON TRANSFER REACTIONS OF THE TYPE $(d,^7Li)$, $(d,^7Be)$, AND $(d,^9Be)$ AT 15 MeV. Denes, L. J.; Daehnick, W. W. (Univ. of Pittsburgh). Phys. Rev., 154: 928-33(Feb. 20, 1967).

Differential cross sections were measured for $(d,^7Li)$ and $[d,^7Li^*(0.478)]$ reactions from ^{13}C, ^{17}O, ^{18}O, and ^{19}F as well as for $^{19}F(d,^7Be)$, $^{19}F[d,^7Be^*(0.432)]$, $^{19}F(d,^9Be)^{12}C$, and $^{19}F(d,^9Be)^{12}C^*$ (4.43), utilizing simultaneous time-of-flight and energy analysis. All 12 angular distributions for these many-nucleon transfer reactions were obtained at incident deuteron energies near 15 MeV, and show forward peaking and noticeable, diffraction-like structure as well as large total cross sections ($0.1 < \sigma_{tot} < 1.8$ mb). Hence most $(d,^7Li)$ cross sections reported here are comparable in magnitude to those of $(d,^6Li)$ reactions from corresponding targets. An interpretation of these many-nucleon transfers in terms of a simple direct-reaction model is attempted. Distorted-

wave Born-approximation (DWBA) calculations were made, analogous to earlier calculations for (d,^{6}Li) angular distributions on similar targets. DWBA curves with a damped diffraction structure are obtained easily, since for 5-nucleon transfers, the angular distribution usually has contributions from two different l transfers. The DWBA calculations for these reactions yield the correct order of magnitude for the absolute total cross sections, and qualitative agreement in the angular distributions. Tentative spectroscopic coefficients are extracted from the comparison of experiment and calculations. (auth)

19195 ELECTROMAGNETIC DECAY OF THE ^{14}N 3.95- AND 7.03-MeV LEVELS. Olness, J. W.; Poletti, A. R.; Warburton, E. K. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 154: 971-80(Feb. 20, 1967). (BNL-10629).

The ^{12}C(^{3}He,pγ)^{14}N reaction was used to study the electromagnetic decay of the 3.95- and 7.03-MeV states of ^{14}N. Angular distributions of the 3.95 → 0 and 3.95 → 2.31 transitions were measured with a three-crystal pair spectrometer at a ^{3}He bombarding energy of 2.2 MeV. Analyses of these data determine solutions for x, the E2/M1 mixing ratio for the ground-state transition, of x = −0.37 ± 0.04 or x = −2.80 ± 0.27, where the phase convention is that of Litherland and Ferguson. Branching ratios of 3.7 ± 0.3% and 96.3 ± 0.3% were determined for transitions from the 3.95-MeV state to the ground state and to the 2.31-MeV first excited state, respectively. Combining these results with the previously determined E2 radiative width of the 3.95 → 0 transition, it is seen that the smaller (in magnitude) solution for x corresponds to an inordinately large M1 strength for both the 3.95 → 0 $\Delta T = 0$ and 3.95 → 2.31 $\Delta T = 1$ transitions. For the larger value, x = −2.80 ± 0.27, the radiative widths are $\Gamma_\gamma(M1) = 0.140 \pm 0.013$ eV for the 3.95 → 2.31 transition and $\Gamma_\gamma(M1) = 5.8 \pm 1.2 \times 10^{-4}$ eV for the 3.95 → 0 transition. Gamma-ray coincidence studies employing NaI(Tl) spectroscopy were also carried out at a ^{3}He bombarding energy of 6.0 MeV to determine the gamma branching of the ^{14}Ni 7.03-MeV level to known lower lying levels. Branchings of 0.5 ± 0.1% and 0.9 ± 0.25% were determined for transitions to the first and second excited states of ^{14}N, respectively, while upper limits of 0.4% (or less) were placed on possible transitions to the other excited states. Combining this with previous work gives an E2 radiative width for the 7.03 → 2.31 $\Delta T = 1$ transition of 6 ± 1.4 × 10^{-4} eV, and a total radiative width for the 7.03 → 3.95 $\Delta T = 0$ transition of 11 ± 3 × 10^{-4} eV. (auth)

19196 CROSS SECTION FOR FORMATION OF ^{7}Be BY 20 TO 155 MeV PROTON-INDUCED REACTIONS IN CARBON. Williams, I. R.; Fulmer, C. B. (Oak Ridge National Lab., Tenn.). Phys. Rev., 154: 1005-7(Feb. 20, 1967). (ORNL-P-2429).

The cross section for the reaction ^{12}C(p,x)^{7}Be was measured as a function of energy from 20 to 155 MeV. A sharp rise above the neighboring thresholds for ^{12}C(p,^{6}Li), ^{12}C(p,αd), and ^{12}C(p,αpn) reactions was observed. The excitation function peaks with a cross section of ~20 mb at 40 MeV and then decreases slowly with increasing energy. No structure is observed at the thresholds for the ^{12}C(p,tdp), ^{12}C(p,3d), or other reactions of higher threshold energy. (auth)

19197 ISOSPIN CONSERVATION IN THE REACTION ^{12}C(α,d)^{14}N. Zafiratos, C. D. (Oregon State Univ., Corvallis); Lilley, J. S.; Slee, F. W. Phys. Rev., 154: 887-90(Feb. 20, 1967).

Cross sections for the formation of 24 states between 0 and 13-MeV excitation in ^{14}N via the ^{12}C(α,d)^{14}N reaction were measured. Six T = 1 levels could have been observed if the $\Delta T = 0$ selection rule for this reaction had been violated. None of these T = 1 levels were observed to be excited. From the upper limits on their cross sections, isospin impurities in the wave functions of the 8.06-, 9.51-, and 10.43-MeV T = 1 levels were deduced to be less than 50, 15, and 24%, respectively. These experimental upper limits are still somewhat larger than crude theoretical estimates of the isospin mixing induced by the Coulomb interaction. (auth)

19198 THE INELASTIC SCATTERING OF 45.5 MeV PROTONS BY BERYLLIUM AND CARBON. Petersen, Edward Leland. Los Angeles, Univ. of California, 1966. 78p.

Thesis.

The differential cross sections for the excitation of nine levels of C and one level of Be are reported for 35 angles from 15 to 150°. The results for the 2.43 MeV level of Be and the 4.4 and 9.6 MeV levels of C have an average relative accuracy of 3% while the 7.6, 10.8, 11.8, 12.7, 14.0, 15.1, and 16.1 MeV levels of C have an average accuracy of 10%. The cross sections change by one to three orders of magnitude from forward to backward angles. Levels at 13.3 and 16.6 MeV in C were not observed. The experimental apparatus is described; and the 2.43, 4.4, 7.6, and 9.6 MeV angular distributions are compared with distorted-wave calculations. (Dissertation Abstr.)

19199 POLARIZATION OF PROTONS SCATTERED ELASTICALLY FROM ^{4}He. Jahns, Monroe Frank. Austin, Tex., Univ. of Texas, 1966. 87p.

Thesis.

The polarization of protons scattered elastically from ^{4}He was measured at the following points (the incident proton energy in MeV is followed by the laboratory scattering angles): 6.00, 37.7°; 7.89, 37.7°, 45.5°; 9.89, 37.7°, 45.5°, 60.8°, 75.6°, 85.3°, 100.0°; 11.16, 85.3°, 100.0°. The targets used were thin-wall cylindrical gas cells. A second scattering from a ^{12}C foil was used to analyze the polarization. The results of this experiment combined with the polarization measurements by R. I. Brown, W. Haeberli, and J. X. Saladin (Nuclear Physics, 47: 212(1963)) and with the p-^{4}He elastic cross-section measurements by A. C. L. Barnard, C. M. Jones, and J. L. Weil (Nuclear Physics, 50: 604(1964)) were used to make a phase-shift analysis of p-^{4}He scattering. Polarizations and cross sections calculated from the phase shifts obtained are in excellent agreement with the measured values. (Dissertation Abstr.)

19200 PROTON ELASTIC SCATTERING FROM ^{13}C. Aguilar, Victor Latorre. College Park, Md., Univ. of Maryland, 1966. 138p.

Thesis.

The differential cross section for elastic scattering of protons from ^{13}C was measured to an accuracy of 7% for proton energies from 1.0 to 2.6 MeV at center-of-mass scattering angles of 39.2, 54.7, 90.0, and 125.3°. Thin targets were prepared from methyl iodide enriched to 62% in ^{13}C, and the scattered protons were analyzed using a double-focussing magnetic spectrometer. Proton groups corresponding to ^{12}C and ^{13}C were cleanly separated except for energies below 1.8 MeV at 39.2 and 54.7°. A theoretical curve calculated from a two-level formula was fitted to the data over the entire energy range. Seven resonances, all previously observed, were necessary to fit the data. The laboratory resonance energies (MeV), reduced widths (MeV-cm × 10^{-13}), and J^π values assigned in this analysis are as follows: 1.150 ± 0.002, 0.19, 0^+; 1.366 ± 0.050, 3.60, 0^-; 1.461 ± 0.003, 1.76, 3^-, 1.540 ± 0.003, 0.09, 2^+; 1.980 ± 0.003, 0.45, $3^-(2^-)$; 2.110 ± 0.003, 1.66, 2^-; 2.319 ± 0.005, 0.09, 1^+. These resonance energies and reduced widths are in fair agreement with previous measurements. The spin and parity assignments for all levels, except those at E_p = 1.540 and 1.980 MeV, confirm previous experiments. The 1.540-MeV resonance had previously been assumed to have $J^\pi = 1^+$, and the 1.980-MeV resonance had been assigned $J^\pi = 1^-$. Comparison of experiment and theory suggests the possibility of a broad resonance having $J \leq 1$ in the vicinity of E_p = 2.8 MeV. (Diss. Abstr.)

19201 MANY-NUCLEON TRANSFER REACTIONS IN LIGHT NUCLEI. Denes, Louis Julius. Pittsburgh, Univ. of Pittsburgh, 1965. 110p.

Thesis.

Differential cross sections were measured for (d,^{6}Li) reactions from ^{12}C, ^{13}C, ^{16}O, ^{17}O, ^{18}O, and ^{19}F for (d,^{7}Li) and (d, ^{7*}Li .478) reactions from ^{13}C, ^{17}O, ^{18}O, ^{19}F as well as ^{19}F(d,^{7}Be), ^{19}F(d,^{7*}Be .432), ^{19}F(d,^{9}Be)^{12}C and ^{19}F(d,^{9}Be)^{12*}C 4.43. All 18 angular distributions for these many-nucleon transfer reactions were obtained at incident deuteron energies near 15 MeV and show large total cross sections (0.1 to 4.0 mb), diffraction-like structure, forward peaking, and minor sensitivity to energy changes of a few hundred keV. In addition, the elastic scattering of deuterons was measured for ^{12}C, ^{13}C, ^{16}O, ^{17}O, ^{18}O, and ^{19}F targets, also at energies near 15 MeV. Optical-model analyses of the elastic scattering were made with and without a spin-orbit interaction. Interpretation of the many-nucleon transfer reactions is by simple distorted-wave-Born-approximation (DWBA) direct reaction calculations. The reaction is calculated in the extreme cluster limit, i.e., a ^{4}He, ^{5}He, ^{5}Li, or ^{7}Li cluster with predictable quantum numbers is assumed to exist (in a Saxon well) at the instant of the reaction and to be picked up as a whole. In spite of the simplicity of the model and the uncertainty in the outgoing projectile waves, reasonable qualitative agreement of data and calculations was found in most cases. The DWBA predictions also appear to be in general agreement with the absolute magnitude of the reactions. Spectroscopic factors for (d,^{6}Li) reactions in p-shell nuclei are large, but it is interesting to note that for clusters made up of 1p and 2s,1d nucleons, the enhancement of ^{5}He clusters is quite comparable to the enhancement of ^{4}He clusters. These observations indicate that clustering of nucleons may be in agreement with simple shell-model expectations for light elements. (Dissertation Abstr.)

19202 ANGULAR DISTRIBUTIONS AND EXCHANGE EFFECTS IN THE REACTION ^{19}F(d,α)^{20}Ne. Warshaw, Stephen Isaac. Baltimore, Johns Hopkins Univ., 1966. 166p.

Thesis.

Angular distributions of neutrons from the reactions $^{19}F(d,n)^{20}Ne$ leaving ^{20}Ne in the ground and first excited states were measured at deuteron bombarding energies of 1.0, 1.5, 2.0, 2.2, and 2.5 MeV. Excitation functions at 0 and 120° were measured in 100-keV steps from 0.9 to 2.7 MeV. The differential cross section for production of first excited state neutrons was measured to be 7.4 ± 0.8 millibarns per steradian at 0° with a beam energy of 2.00 MeV. A single stilbene crystal employing pulse-shape discrimination was used to detect the neutrons. The angular distributions were analyzed in terms of a dual-mode plane-wave theory which formally incorporates exchange and interference terms. It is found that the gross features of the distributions as a function of energy can be qualitatively accounted for by this model. Both sets of excitation functions exhibit fluctuations which include a broad peak at 2 MeV, and which also appears to be present in the total cross section for the first excited state neutrons. It is tentatively proposed that this suggests the presence of groups of closely spaced levels of unusually high excitation of ^{21}Ne. A description of the apparatus and associated techniques is presented. (Dissertation Abstr.)

Nuclear Properties and Reactions, $20 \leq A \leq 89$

Refer also to abstracts 17672, 18301, 18803, 19152, 19191, 19192, 19202, 19257–19259, 19264, 19296, 19324, and 19341.

19203 (IS-1420) SU_3 PARTICLE-HOLE STATES IN ^{40}Ca. Larner, Donald; Williams, S. A. (Ames Lab., Iowa). Dec. 1966. Contract W-7405-eng-82. 101p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The contributions of the one-particle, one-hole excitations to the negative-parity levels of ^{40}Ca are calculated. The basis states are harmonic oscillator states symmetrized according to SU_3; and in the process of constructing these states, some Clebsch-Gordan coefficients for the (30) representation are computed. The residual interaction employed is the Kallio-Kolltveit potential, which uses the Moszkowski-Scott separation method. The energy matrix is computed directly from the SU_3 states, using the projection integral method of Elliott. Nine states are obtained, seven of which may be compared with experimental data on the low-lying states of ^{40}Ca. Five of these seven states show very good agreement with experiment. (auth)

19204 MEASUREMENT OF TRUE ANGULAR CORRELATION IN ^{57}Fe IN A SINGLE CRYSTAL OF METALLIC COBALT. Chandra, Girish (Tata Inst. of Fundamental Research, Bombay). Proc. Indian Acad. Sci., Sect. A, 65: 25-9(Jan. 1967).

Unperturbed angular correlation in ^{57}Fe was observed in a single crystal of metallic Co. The value of the angular correlation coefficient, $A_2 = -0.042 \pm 0.016$, gives the mixing ratio $\delta = -0.17 \pm 0.03$ for the 122-keV gamma transition. (auth)

19205 CORRELATION FUNCTION OF A $\gamma-\gamma$ CASCADE (0.34 MeV–1.38 MeV) ON ^{49}Ti. Honzatko, J.; Kajfosz, J. (Nuclear Research Inst., Czechoslovak Academy of Sciences, Rez). Czech. J. Phys., B17: 259-63(1967).

The angular correlations of a cascade of capture gamma rays with energies of $E_1 = 0.34$ MeV, and $E_2 = 1.38$ MeV on ^{49}Ti nuclei were measured. The results confirm that it is a cascade of the type $\frac{1}{2}^-(M1 + E2)\frac{3}{2}^-(E2)\frac{7}{2}^-$ with a mixing parameter of the first transition $\delta = -0.1$, or $\delta = +2.2$. (auth)

19206 MAGNETIC ANALYSIS OF THE $^{55}Mn(d,p)^{56}Mn$ REACTION. I. EXCITED STATES OF ^{56}Mn. Garcia, A. (Instituto de Fisica Corpuscular, Valencia); Lopez, A.; Senent, F.; Hinds, S. An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 41-50 (Jan.-Feb. 1967).

The energy spectra of the protons emitted from a manganese target bombarded with 10.1-MeV deuterons were measured at 24 angles between 5 and 175° with a high-resolution multi-angle magnetic spectrograph. A total of 165 proton groups was ascribed to levels of ^{56}Mn up to an excitation energy of 6 MeV. (auth)

19207 TRITON REACTIONS WITH ^{30}Si. PART 2. THE NUCLEAR REACTION $^{30}Si(t,n)^{32}P$. Jantsch, K. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 348-51 (Nov. 1966). (In German).

It is shown that ^{32}P is formed in neutron-exposed samples of Li_2SiO_3 due to the nuclear reaction $^{30}Si(t,n)^{32}P$. The ^{32}P background due to the impurities of the targets such as phosphorus, sulphur, or chlorine may strongly be reduced by using extra-pure initial materials. The cross section of 216 ± 67 mb determined for 2.73-MeV tritons is in good agreement with the theoretical value of 190 mb calculated from the compound-nucleus model. (auth)

19208 LOWEST T = 2 STATES IN ^{20}Ne AND ^{24}Mg. Adelberger, E.; McDonald, A. B. (California Inst. of Tech., Pasadena). Phys. Lett., 24B: 270-3(Mar. 20, 1967).

Precise values for the excitation energies of the lowest T = 2 states in ^{20}Ne and ^{24}Mg were obtained. These states are strongly populated in the $^{18}O(^3He,n)$ and $^{22}Ne(^3He,n)$ reactions. The angular distributions are well described by DWBA double stripping theory. (auth)

19209 AN ISOBARIC ANALOG STATE WITH $1f_{\frac{7}{2}}$ CONFIGURATION IN ^{37}Cl. Hyder, A. K. Jr.; Harris, G. I. (Aerospace Research Labs., Wright-Patterson Air Force Base, Ohio). Phys. Lett., 24B: 273-6(Mar. 20, 1967).

A strong $J^\pi = \frac{1}{2}^-$, $T = \frac{5}{2}$ resonance was found at $E_p = 1887$ keV in $^{36}S(p,\gamma)^{37}Cl$ and was identified as the analog of the ^{37}S ground state. The resonance decays predominantly to the 3.105-MeV level, which has $J^\pi = \frac{1}{2}^-$, $T = \frac{5}{2}$. The 3.105 → 0 transition is mixed M2–E3. (auth)

19210 A SEARCH FOR THE 1.65- AND 1.83-MeV LEVELS IN ^{27}Al. Divatia, A. S.; Mehta, M. K.; Kerekatte, S. S. (Atomic Energy Establishment, Trombay, India). Indian J. Pure Appl. Phys., 4: 478-9(1966).

A search was made for the recently reported levels in ^{27}Al, at 1.65 and 1.83 MeV, utilizing the reaction $^{27}Al(p,p')^{27}Al^*$ for incident proton energies of 3.5 to 5.5 MeV. No positive evidence was found for the existence of these levels. An upper limit of 0.4 mb/sterad was obtained for the differential cross section for exciting these levels in the range of proton energies covered. (auth)

19211 THERMAL NEUTRON CAPTURE CROSS SECTION AND RESONANCE CAPTURE INTEGRAL OF ^{22}Na. Sims, G. H. E. (Atomic Energy of Canada Ltd., Ottawa). J. Inorg. Nucl. Chem., 29: 593-7(Mar. 1967).

The effective neutron capture cross section of ^{22}Na was measured by a depletion method with and without a cadmium cover. Using the Westcott convention the 2200-m/sec cross section was calculated to be 35,900 ± 1,200 b, and the resonance integrals Σ and Σ' were calculated to be 203,000 ± 27,000 and 191,000 ± 25,000 b, respectively. In the calculations it was assumed that the cross section of ^{22}Na followed the 1/v law in the thermal region. All measurements are relative to a ^{59}Co cross section of 37.5 b, and the quoted errors are at the 95% confidence level. (auth)

19212 EFFECTS OF PAIRING IN THE ^{20}Ne NUCLEUS. Kalman, C. S.; Bernier, J.-P.; Harvey, M. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 45: 1297-1303 (Mar. 1967). (AECL-2848).

An investigation is made into the effects of a perturbing pairing force on the structure of the ^{20}Ne nucleus described primarily by a quadrupole-quadrupole force (SU_3 model). It is shown that such a perturbation can not explain simultaneously the observed deviations from the SU_3 predictions of energy and the B(E2) systematics in the "ground-state band." (auth)

19213 PHOTODEUTERON YIELDS. II. ZINC. Acquadro, J. C.; Cesar, R. O.; Goldemberg, J.; Hamburger, E. W. (Univ., Sao Paulo, Brazil). An. Acad. Brasil. Cienc., 38: 257-60(June 1966).

A Zn foil was bombarded by the 22-MeV bremsstrahlung beam of the São Paulo betatron. The emitted protons, deuterons, and alpha particles were detected in nuclear emulsions placed at the periphery of a homogeneous magnetic field through which the particles passed. The particles were identified by their range in the emulsion together with their magnetic rigidity, which is given by the angle of incidence in the emulsion. The alpha particle yield is 7.8 ± 1.5% of the proton yield and the deuteron yield is less than 2% of the proton yield. (auth)

19214 THE TOTAL CROSS SECTION OF THE $^{55}Mn(d,p)^{56}Mn$ REACTION FROM E_d = 500 TO 700 keV. Mesko, Laszlo; Uray, Istvan. ATOMKI (At. Kut. Intez.) Kozlem., 8: 288-93(Dec. 1966). (In Hungarian).

The total cross section of the $^{55}Mn(d,p)^{56}Mn$ reaction was measured in the bombarding deuteron energy range of 500 to 700 keV by the activation method using a thin Mn_3O_4 target. A great difference exists between the experimental excitation function and the curve corresponding to the transmission probability of the Coulomb barrier. (auth)

19215 A STUDY OF (α,d) REACTION ON ^{40}Ca NUCLEI. Benisz, J.; Grotowski, K.; Freindl, L.; Karcz, W.; Jasielska, A.; Panek, T.; Wiktor, S. (Inst. of Nuclear Physics, Krakow). Acta Phys. Pol., 31: 299-306(Feb. 1967).

The reaction $^{40}Ca(\alpha,d)^{42}Sc$ was studied using an α-particle beam with an energy of 24.7 ± 0.1 MeV. Deuteron spectra were obtained by two independent techniques: magnetic analyzer and solid-state counter telescope. Transitions to the excited states

of ^{42}Sc at 0.61, 1.50, 2.18, 2.93, and 3.73 MeV and a very weak transition to the ground state were detected. Angular distributions for transitions to the highly populated levels at 0.61 and 1.50 MeV of the final nucleus were measured. Relative intensities of the observed transitions are discussed according to the selection rules for the two-nucleon-transfer reactions. (auth)

19216 THE EVALUATION OF THE ANGULAR DISTRIBUTION IN THE REACTION ^{28}Si(d,p)^{29}Si (E_d = 15 MeV) IN BUTLER AND DAR APPROXIMATIONS. Gyarmati, Borbala; Vertse, Tamas. ATOMKI (At. Kut. Intez.) Kozlem., 8: 314-26(Dec. 1966). (In Hungarian).

Algol programs were written for the evaluation of the angular distributions from (d,p) and (d,n) stripping reactions on the basis of Butler's and Dar's formula. The evaluation of the angular distributions belonging to the Q = 4.975, 4.226, 0.316, and 0.064 MeV transitions of the ^{28}Si(d,p)^{29}Si (E_d = 15 MeV) reaction was carried out. Neither Dar's nor Butler's formula was able to explain the maxima occurring at small angles. According to the results, Dar's formula does not determine the orbital angular momentum of the captured nucleon as sharply as Butler's theory does; the l value producing the best fit by a reasonable value of R may even be misleading. (auth)

19217 PHOTOPROTONS FROM NUCLEI OF AVERAGE WEIGHT (50 ≤ A ≤ 125) AND THE MECHANISM OF DECAY OF EXCITED NUCLEI IN THE REGION OF THE DIPOLE GIANT RESONANCE. Osokina, R. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 36: 140-213(1966). (In Russian).

Enriched targets of ^{58}Ni, ^{60}Ni, ^{64}Ni, ^{65}Cu, ^{93}Nb, ^{114}Cd, ^{114}Sn, ^{124}Sn, ^{121}Sb, ^{123}Sb and a natural mixture of the zinc isotopes were prepared as thin targets 25 to 30 microns thick, and were hit by high-energy gamma rays of 20 to 30 MeV in energy. The proton energy and distribution were determined by measuring the proton tracks in nuclear emulsion stacks. The proton energy was obtained from the range in the nuclear emulsion. The yields of photoprotons from nuclei of average weight (20 < Z < 60) with excitation in the region of the giant resonance exceeds the yields predicted by the evaporation model. The yield of photoprotons decreases with increasing atomic weight A for a given atomic number Z. The angular distributions can be approximated by the equation: $(\theta) = a + b \sin^2\theta$, which is evidence of the dipole character of the gamma absorption for 50 < A < 125 and E_γ = 28 MeV. The photoproton spectra can be interpreted in the framework of a particle-hole model and can serve as a source of information of the inner nuclear levels. (TTT)

19218 THE ABSORPTION CROSS SECTION OF γ QUANTA BY ^{19}F, ^{24}Mg, ^{27}Al, AND ^{40}Ca NUCLEI IN THE REGION OF THE DIPOLE GIANT RESONANCE. Nikolaev, F. A. Tr. Fiz. Inst., Akad. Nauk SSSR, 36: 84-139(1966). (In Russian).

A magnetic pair spectrometer was used to determine directly the gamma absorption cross sections of ^{19}F, ^{24}Mg, ^{27}Al, and ^{40}Ca. The gamma beam struck a gold foil having a thickness of 10 mg/cm^2, and the electron-positron pairs were bent in opposite directions by the magnetic field and were collected by a system of slits backed by scintillators and light guides. The system had a high resolution (about 1% for 10 to 30 MeV gammas) and a high counting rate. The amplitude of the light pulses was determined by a coincidence counting scheme, and served as a measure of the gamma energy. An analysis of the data showed a significant structure in the gamma absorption cross sections and the existence of levels with the following excitation energies: (10.1), 11.4, 14.0, 16.8, 19.5, 24.0, and 28.0 MeV for ^{19}F; 11.2, (13.8), 17.1, 18.9, 20.4, 22.9, 24.9, and 27.0 MeV for ^{24}Mg; 12.5, 19.1, 21.1, 24.4, and 26.1 MeV for ^{40}Ca; and a large number of unresolved resonances at excitation energies of 10 to 30 MeV for ^{27}Al. The structure is more obvious in the even-even nuclei than in the odd-even nuclei at a resolution of about 200 keV. Theoretical calculations on the basis of the shell model only gave qualitative agreement with the experimental data. The form and magnitude of the gamma absorption cross section are determined by general properties of the nucleus which depend very little on the model that is used. The charge distribution radii were found to be 2.73 ± 1.17^{-13} cm for ^{19}F, $2.46 \pm 0.77 \times 10^{-13}$ cm for ^{24}Mg, $3.04 \pm 0.98 \times 10^{-13}$ cm for ^{27}Al, and $3.42 \pm 1.00 \times 10^{-13}$ cm for ^{40}Ca. (TTT)

19219 INELASTIC SCATTERING OF MONOCHROMATIC PHOTONS FROM THE 7.64-MeV LEVEL OF ^{62}Ni. Estes, G. P. (Univ. of Virginia, Charlottesville); Min, K. Phys. Rev., 154: 1104-8(Feb. 20, 1967).

The nuclear resonant scattering of the monochromatic iron capture gamma rays from natural nickel was studied with a single NaI crystal and a three-crystal pair spectrometer. The spectrum of the scattered photons exhibits three photon groups of 7.64, 6.47, and 5.38 MeV with relative intensities 0.69, 0.08, and 0.23, respectively. The spectrum of the low-energy cascade photons in coincidence with the scattered photons identifies these groups with the transitions from the 7.64-MeV resonant level to the 0^+ ground state and the first (2^+, 1.17-MeV) and second (0^+, 2.05-Mev) vibrational levels in ^{62}Ni. Angular-distribution measurements of the elastically scattered photons show that the 7.64-MeV level in ^{62}Ni has angular momentum 1. The elastic-scattering cross section averaged over the incident gamma rays was determined to be 190 ± 40 mb. (auth)

19220 GAMMA DECAY OF $Se^{73m,g}$ AND $Se^{81m,g}$ ISOMERIC PAIRS. Rao, P. Venugopala; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 154: 1028-32(Feb. 20, 1967). (ORO-3346-4).

The gamma decay of the isomeric pairs (42-min ^{73m}Se, 7-h ^{73g}Se), and (57-min ^{81m}Se, 18.6-min ^{81g}Se) was investigated with Ge(Li) and NaI(Tl) detectors by means of singles, coincidence, and sum-peak coincidence spectrometry. The half lives of ^{73g}Se and ^{81m}Se were determined to be 7.0 ± 0.1 hr and 56.6 ± 0.6 min, respectively. The gamma energies from 7-h ^{73g}Se were determined to be 66.9 ± 0.5 and 360.4 ± 0.5 keV. A previously unreported gamma of 75.7 ± 0.5 keV was found in 42-min ^{73m}Se decay and is placed as the ground-state transition from a 76-keV level ($\frac{1}{2}$-, $\frac{3}{2}$-) in ^{73}As. The absence of a 42-min component in the intensity of the 67-keV gamma indicates that the 67-keV ($\frac{5}{2}$-) first excited state of ^{73}As is not fed from 42-min ^{73m}Se either directly or through the 76-keV state. The energies and relative intensities of seven gammas in ^{81m,g}Se equilibrium decay were measured: 102.7 ± 0.5 (100) (isomeric transition), 275.8 ± 0.5 (10.2), 289.9 ± 0.5 (8.7), 539.0 ± 0.5 (0.8), 553.0 ± 0.5 (1.5), 566.1 ± 0.5 (2.9), and 829.0 ± 0.5 (4.9) keV. A previously unreported level at 539.0 keV is proposed tentatively in ^{81}Br with a possible spin-parity of $\frac{5}{2}$- or $\frac{7}{2}$-. Decay schemes are proposed for ^{73m,g}Se and ^{81m,g}Se which are consistent with all available data. (auth)

19221 NEUTRON REACTION CROSS SECTIONS OF SELENIUM AND IRON AT 14.4 MeV. Rao, P. Venugopala; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 154: 1023-8 (Feb. 20, 1967). (ORO-3346-2(Rev.)).

Fast-neutron activation cross sections of selenium and iron were measured with an improved technique that takes advantage of the high resolution of Ge(Li) detectors. Powdered samples, mixed with iron and/or aluminum powders to act as neutron-flux monitors, were irradiated with 14.4 ± 0.3-MeV neutrons, and the decay of gamma spectra was followed with a thin Ge(Li) detector having a resolution of 4 keV (full width at half-maximum). The following cross sections (in millibarns) were determined: ^{74}Se(n,2n)^{73g}Se, 293 ± 29; ^{74}Se(n,2n)^{73m}Se, 65 ± 15; ^{74}Se(n,p)^{74}As, 107 ± 11; ^{76}Se(n,2n)^{75}Se, 808 ± 81; ^{76}Se(n,p)^{76}As, 56 ± 6; ^{78}Se(n,p)^{78}As, 24 ± 2.4; ^{78}Se(n,α)$^{75(m+g)}$Ge, 6 ± 1.0; ^{80}Se(n,2n)^{79m}Se, 680 ± 100; ^{80}Se(n,α)$^{77(m+g)}$Ge, 2–9; ^{82}Se(n,2n)^{81m}Se, 894 ± 89; ^{82}Se(n,2n)^{81g}Se, 225 ± 45; ^{54}Fe(n,p)^{54}Mn, 259 ± 26; and ^{54}Fe(n,α)^{51}Cr, 90 ± 10. Systematic trends in these cross sections are discussed and are compared with the available theoretical computations. The $2p_{3/2}$ proton subshell-closure effect in the Ga–Ge–As region for (n,α) cross sections suggested by Chatterjee is confirmed. For ^{81}Se the spin cutoff parameter is calculated to be 2.9 ± 0.4 from the isomer ratio σ_m/σ_g = 4.0 ± 0.9, and the ratio of the moment of inertia I associated with the spin distribution to the rigid-body moment of inertia I_R is obtained as $I/I_R \approx 1.0$. (auth)

19222 LIFETIME OF THE ^{21}F 0.28-MeV LEVEL. McDonald, R. E.; Becker, J. A. (Lockheed Palo Alto Research Lab., Calif.). Phys. Rev., 154: 1101-3(Feb. 20, 1967).

The mean lifetime of the first excited state of ^{21}F at 0.28 MeV was measured to be $8.31 \pm 0.36 \times 10^{-9}$ sec, consistent with a transition multipolarity E2. Also, the angular distribution of the gamma radiation following the decay of this level (employing the geometry of Litherland and Ferguson) was found to be isotropic. The ^{19}F(t,p)^{21}F reaction was used to populate the 0.28-MeV level of ^{21}F. (auth)

19223 ACTIVATION CROSS SECTIONS OF GERMANIUM FOR 14.4-MeV NEUTRONS. Wood, R. E.; Cook, W. S.; Goodgame, J. R.; Fink, R. W. (Georgia Inst. of Tech., Atlanta). Phys. Rev., 154: 1108-10(Feb. 20, 1967).

^{72}Ga, ^{73}Ga, ^{74}Ga, ^{69}Ge, ^{75}Ge, ^{69m}Zn, and ^{71m}Zn were produced by irradiating natural germanium with 14.4 ± 0.3-MeV neutrons. Two mixtures of powders containing GeO_2 + Al + Fe and GeO_2 + Al + Cu also were irradiated. The activities were identified from gamma spectra taken with a Ge(Li) detector and the cross sections were measured using the improved technique described by Rao and Fink. The reactions for which cross sections were measured are: ^{70}Ge(n,2n)^{69}Ge, 447 ± 45 mb; ^{76}Ge(n,2n)^{75}Ge, 1236 ± 120 mb; ^{72}Ge(n,p)^{72}Ga, 47.4 ± 4.7 mb; ^{73}Ge(n,p)^{73}Ga, 26.4 ± 2.6 mb; ^{74}Ge(n,p)^{74}Ga, 13.2 ± 1.3 mb; ^{72}Ge(n,α)$^{69m+g}$Zn, 15.2 ± 1.5 mb; and ^{74}Ge(n,α)$^{71m+g}$Zn, 13.3 ± 1.3 mb. For all cases where isomers exist, the cross section value is total for m + g. The ^{76}Ge(n,2n)^{75}Ge (82-min) cross section also was checked by beta counting, which

is independent of decay-scheme assumptions. The results are compared with the systematics of (n,2n), (n,p), and (n,α) cross sections at 14 to 15 MeV. (auth)

19224 SPIN ASSIGNMENTS IN THE 2p SHELL FROM J DEPENDENCE IN (d,p) ANGULAR DISTRIBUTIONS. Lee, L. L. Jr.; Schiffer, J. P. (Argonne National Lab., Ill.). Phys. Rev., 154: 1097-1100(Feb. 20, 1967).

The empirically established J dependence in (d,p) angular distributions is used to assign spin values to energy levels in the nuclei ^{47}Ti, ^{49}Ti, ^{51}Ti, ^{51}Cr, ^{59}Fe, and ^{65}Ni, most of which are populated by l = 1 (d,p) transitions with large cross sections. The results are in general agreement with available nuclear-structure calculations. (auth)

19225 DECAY OF ^{57}Ni AND EXCITED LEVELS IN ^{57}Co. Bakhru, H. (Yale Univ., New Haven); Preiss, I. L. Phys. Rev., 154: 1091-6(Feb. 20, 1967). (YALE-2726-H-86).

The decay of ^{57}Ni was investigated in order to obtain detailed information about the level structure of the odd-even ^{57}Co. Lithium-drifted germanium detectors as well as standard scintillation-spectrometry techniques were used. The levels at 1.46, 1.59, 1.75, and 2.62 MeV were established with direct de-excitation of the ^{57}Co ground state, in addition to the already known levels at energies of 1.37, 1.497, and 1.9 MeV. It was confirmed that the 1.497-MeV level is the only one which decays by a 0.127–1.37 MeV cascade of gamma rays. The various gamma-gamma coincidence studies were performed on the basis of the results, and on the ratios of electron capture to β^+ decay, a decay scheme of ^{57}Ni is proposed; and the results are discussed in the light of the Coriolis coupling model. The half life of the 1.497-MeV level was measured to be $0.60 \pm 0.05 \times 10^{-9}$ sec, and an upper limit for the half life of the 1.37-MeV level is given as $\sim 2 \times 10^{-10}$ sec. (auth)

19226 NUCLEAR-STRUCTURE STUDIES OF ^{55}Co AND ^{57}Co BY MEANS OF THE ^{54,56}Fe(^{3}He,d) REACTION. Rosner, Baruch; Holbrow, C. H. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 154: 1080-7(Feb. 20, 1967).

A high-resolution study of the ^{54,56}Fe(^{3}He,d)^{55,57}Co reactions at 16.5-MeV bombarding energy was performed. Twenty-five states of ^{55}Co and 41 states of ^{57}Co below 8-MeV excitation energy were identified. The angular distribution of deuterons at forward angles was measured, and with the aid of distorted-wave Born approximation predictions, values of angular momentum transfers and spectroscopic factors were evaluated for the more intense transitions. Analog states to some of the low-lying states in ^{55}Fe and ^{57}Fe were identified, and Coulomb displacement energies of 9.00 ± 0.03 and 8.90 ± 0.03 MeV were determined for the ^{55}Co–^{55}Fe and ^{57}Co–^{57}Fe pairs, respectively. The location of $1f_{\frac{7}{2}}$, $2p_{\frac{3}{2}}$, and $2p_{\frac{1}{2}}$ single-particle proton states by means of the "centroid method" is discussed and is evaluated for the case of ^{55}Co. (auth)

19227 POLARIZATION AND DIFFERENTIAL CROSS SECTIONS OF PROTONS FROM THE ^{58}Ni(d,p)^{59}Ni REACTION. Rollefson, A. A.; Brown, P. F.; Burke, J. A.; Crowley, P. A.; Saladin, J. X. (Univ. of Pittsburgh). Phys. Rev., 154: 1088-90 (Feb. 20, 1967).

The polarization of the proton groups leading to the ground state and excited states at 0.471, 0.887, and 1.318 MeV in ^{59}Ni was measured in the angular range of 10° to 30° at an average incident-deuteron energy of 14.5 MeV. A strong dependence on the total angular-momentum transfer j_n was observed. In addition to the polarization measurements, the (d,p) differential cross sections were measured. (auth)

19228 SPARK-CHAMBER SEARCH FOR DOUBLE BETA DECAY IN ^{48}Ca. Shapiro, M. H.; Frankel, S.; Koicki, S.; Wales, W. D.; Wood, G. T. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 154: 1050-7(Feb. 20, 1967). (NYO-2171-209).

Double beta decay of ^{48}Ca was sought with a detection system that combines two four-gap aluminum-foil spark chambers of 32-mg/cm^2 thickness with plastic scintillation counters operated in time coincidence. This combined electronic and visual detection system had the advantages of increasing the specificity of the "signature" that can be demanded for double-beta-simulating events and reducing the effective background from γ rays at the low-energy end of the two-electron sum spectrum. This considerably increased the sensitivity for the two-neutrino model of the decay. Approximately 420,000 events were photographed during a 1838.4-hr run with a matrix of source elements consisting of a total of 3 g of ^{48}Ca and dummy elements (a total of 1 g of ^{40}Ca). In a scan of these events, no statistically significant difference between the rate of double-beta-like events from the source and that from the dummy was noted either in the energy region in which two-neutrino double beta decay or in the region in which neutrinoless double-beta decay might be expected to occur. A lower limit of the half life for the two-neutrino mode of the decay was set at 3.2×10^{18} years; for the neutrinoless mode, at 9×10^{18} years. (auth)

19229 STUDIES OF ^{41}Ar FROM THE ^{40}Ar(d,pγ)^{41}Ar REACTION. Allen, J. P. (Yale Univ., New Haven); Howard, A. J.; Bromley, D. A.; Olness, J. W.; Warburton, E. K. Phys. Rev., 154: 1058-67(Feb. 20, 1967). (BNL-10638).

Particle-gamma coincidence measurements on the ^{40}Ar(d,pγ)^{41}Ar reaction were used to determine branching ratios for the gamma deexcitation of several ^{41}Ar states of excitation energy less than 3.5 MeV. Gas targets of 99.6% ^{40}Ar and a deuteron bombarding energy of 3.5 MeV were used for these measurements. Proton-gamma angular correlations were also studied at $E_D = 3.2$ MeV, utilizing a collinear geometry with protons detected in an annular counter placed at 180° and gamma rays detected at several angles between 0° and 90° relative to the beam direction. These data eliminate possible spin assignments of ½ for the levels at 0.517 and 1.354 MeV and when combined with previous work, lead to a $J^\pi = \frac{3}{2}^-$ assignment for both of these states. (auth)

19230 STUDIES ON THE ^{22}Ne(d,pγ)^{23}Ne REACTION. Howard, A. J. (Yale Univ., New Haven); Allen, J. P.; Bromley, D. A.; Olness, J. W.; Warburton, E. K. Phys. Rev., 154: 1067-79 (Feb. 20, 1967). (BNL-10637).

States of ^{23}Ne below 4 MeV in excitation energy were studied via the ^{22}Ne(d,pγ)^{23}Ne reaction. Deexcitation branching ratios for these states were determined by two-parameter analysis of proton-gamma coincidence spectra observed at a bombarding energy $E_d = 3.40$ MeV. Proton-gamma angular correlations were measured in a collinear geometry at $E_d = 2.72$ and 3.52 MeV in order to obtain information on possible spin assignments for the 1.70-, 1.83-, and 2.31-MeV states. Assuming the most probable value of $J = \frac{5}{2}$ for the ^{23}Ne ground state, these results indicate $J = \frac{3}{2}$ or ½ for the 1.70-MeV state and $J = \frac{3}{2}$ for the 1.83-MeV state. A gamma-gamma angular correlation was also studied at $E_d = 2.85$ MeV, leacing, when combined with previous information, to the assignment $J^\pi = \frac{3}{2}^-$ for the 3.22-MeV state. Presently available evidence on the states of ^{23}Ne is shown to be consistent in general with the predictions of a strong-coupling collective model; tentative assignments of members of Nilsson rotational brands are presented for these states. (auth)

19231 A STUDY OF NUCLEAR RESONANCE FLUORESCENCE WITH COMPTON-SCATTERED GAMMA RAYS. Tandon, Gyanendra Kumar. New Haven, Yale Univ., 1965. 124p.

Thesis.

An instrument was developed for exciting nuclear energy levels with monochromatic gamma radiations obtained by using the Compton-scattered gamma rays from a 1.33-MeV ^{60}Co source. With this instrument, it is possible to measure the energies of the excited levels to one part in 1000 as well as to measure the lifetimes of the excited states. The energy of the 963-keV level in ^{63}Cu is determined to be 962.9 ± 1 keV. This is the most accurate measurement of the energy of this level. The mean lifetime of this level was found to be $11.0 \pm 1.6 \times 10^{-13}$ sec. The mean lifetime for the 993-keV level in ^{64}Zn is determined to be $4.03 \pm 0.60 \times 10^{-12}$ sec. The mean lifetime for the 963-keV level in ^{152}Sm is determined to be $7.1 \pm 2.1 \times 10^{-14}$ sec. The above lifetime measurements are in agreement with the previous measurements. A lower limit of 4.8×10^{-13} sec for the partial lifetime for decay to the ground state of the 978-keV level in ^{159}Tb is established. For the ^{159}Tb level, only an upper limit for the total lifetime of 5×10^{-13} sec has been reported previously. An independent measurement of the ratio of the lifetimes has also been done. The ratio of the lifetimes of the 963-keV level in ^{63}Cu and 993-keV level in ^{64}Zn is determined to be 0.273 ± 0.041. The ratio of the lifetimes of the 963-keV levels in ^{63}Cu and ^{152}Sm is determined to be 16 ± 5. (Diss. Abstr.)

19232 MEASUREMENT OF L/K-CAPTURE RATIOS IN ELECTRON-CAPTURING NUCLIDES. Santos-Ocampo, Augusto Galvez. Lafayette, Ind., Purdue Univ., 1961. 118p.

Thesis.

By employing the high-pressure multiwire gas proportional counter, which reduces the probability of K x-ray escape and hence the strong dependence of calculated L/K-capture ratios on the K-fluorescence yield, precise measurements of L/K-capture ratios may be obtained, and with reasonable confidence may be compared with theoretical ratios. The construction of a high-pressure, multiwire proportional counter which essentially consists of a central counter surrounded by an anticoincidence ring without any intervening wall is described. The pulses from the central counter are fed through a low-noise preamplifier to a dc-coupled amplifier which is dc-coupled to a 100-channel analyzer. Pulses from the anticoincidence ring are amplified and fed into a pulse shaper which controls the gate to the analyzer. Whenever a K_αx ray escapes from the center counter and is absorbed in the surrounding layer of the anticoincidence ring, a

pulse develops in the ac ring and triggers the pulse shaper which blocks the analyzer and thus prevents the recording of the L radiation absorbed in the center counter simultaneously with the escape of a $K_\alpha x$ ray. Only a small fraction of $K_\alpha x$ rays escape detection in the anticoincidence ring, and at higher pressures of counting gas this is reduced to a negligible value. This arrangement therefore avoids the recording of spurious L counts which contribute to a high L/K-capture ratio. A more accurate measurement of L/K-capture ratio of ^{37}Ar was obtained, and at the same time the performance of the counter was checked. A value of 0.103 ± 0.003 was measured for ^{37}Ar, which appears in good agreement with Odiot and Daudel's theoretical value of 0.100. The work was extended to include the measurement of the L/K-capture ratio of ^{65}Zn, which was found to be 0.119 ± 0.007. This value is somewhat higher than the theoretical ratio of 0.097 calculated from the data of Brysk and Rose. This appears to substantiate the observation that most of the accurate experimental L/K-capture ratios available in current literature are higher than those theoretically predicted by Brysk and Rose. (Diss. Abstr.)

19233 ON THE ^{44}Sc ISOMER RATIOS AND THE PHOTODISINTEGRATION OF ^{45}Sc. Tatarczuk, Joseph Richard. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 140p.

Thesis.

Isomeric yield ratios were measured for the three reactions ^{45}Sc(γ,n)^{44}Sc, ^{46}Ti(γ,np)^{44}Sc, and ^{45}Sc(n,2n)^{44}Sc. Scandium oxide and titanium samples were irradiated with 48-MeV bremsstrahlung from the Rensselaer Linac to obtain the photo-induced reactions. For the (n,2n) reaction 14-MeV neutrons from the Rensselaer Cockcroft–Walton accelerator were used. The reaction rates were determined by the measurement of the residual gamma activity. A statistical-model calculation of the type used by Huizenga and Vandenbosch was performed in order to obtain the value of the spin cut-off parameter consistent with the experimental data. This parameter characterizes the density of nuclear angular momentum states. The calculated ratios agree with the experimental results for values of the spin cut-off parameter between 2 and 3. Irradiations were made also at maximum bremsstrahlung energies of 24 and 36 MeV to measure the change in the ratio over these energy regions for the (γ,n) reaction. The ratio was found to vary very little. This result is consistent with statistical model calculations. The (γ,n) cross section is almost completely contained in the giant dipole resonance and the photoabsorption is predominantly electric dipole absorption. Therefore, the spin distribution of the compound-nuclear states does not vary as the photon energy is increased. Also, calculated ratios were found to be relatively insensitive to the energy of the emitted neutrons. As a result the model predicts a ratio that is approximately constant. Some integrated photodisintegration cross sections were also measured. Yields relative to the ^{63}Cu(γ,n)^{62}Cu yield were obtained for the reactions: ^{45}Sc(γ,n)^{44}Sc, ^{45}Sc(γ,np)^{43}K, and ^{46}Ti(γ,np)^{44}Sc. The yields were again determined in a second run in which the bremsstrahlung beam was modified by passing it through an absorber and the integrated cross sections were then calculated using Brix' method. The measured (γ,n) cross section is 50% greater than that obtained for the total cross section from sum-rule calculations. (Dissertation Abstr.)

19234 (n,d) REACTION STUDIES ON ^{58}Ni, ^{63}Cu, AND ^{64}Zn. Wang, Wei-noon. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 106p.

Thesis.

Studies were made of (n,d) proton pickup reactions on ^{58}Ni, ^{63}Cu, and ^{64}Zn initiated by 14.1-MeV neutrons. Deuteron spectra at a series of forward angles were measured using a counter telescope; and DWBA fits were made to the data. For ^{63}Cu, the 1.17-MeV, 2^+ vibrational state in ^{62}Ni is excited with a cross section of 0.5 of that of the ^{62}Ni ground state. A strong l = 3 transition to the 3.86-MeV state is observed, which suggests the pickup of the $f_{\frac{5}{2}}$ protons from the core. For ^{64}Zn, transitions to the ground and 0.67-MeV states of ^{63}Cu involve p-particle pickup. Transitions to the 0.96-MeV, $\frac{1}{2}^-$ state are not observed, indicating that the $f_{\frac{5}{2}}$ proton component in the ^{64}Zn ground state is small. Strong transition strength to the 1.33-MeV, $\frac{1}{2}^-$ level suggests that this state has a significant $(f_{\frac{5}{2}})^{-1}$ proton single-particle component, in addition to the core excitations included in recent calculations. In ^{59}Ni excitation of the 1.33-MeV $\frac{3}{2}^-$ state implies that the $1f_{\frac{3}{2}}$ proton orbital is not a good closed shell for the ^{59}Ni nucleus, and there is a significant 2p proton admixture in the ^{58}Ni ground state. (Dissertation Abstr.)

19235 STUDY OF ^{27}Mg WITH (d,p–γ) ANGULAR CORRELATION MEASUREMENTS. Lacambra, Jose Mari. Durham, N. C., Duke Univ., 1966. 162p.

Thesis.

The low-lying excited states of ^{27}Mg were studied with the ^{26}Mg(d,p)^{27}Mg stripping reaction at deuteron bombarding energies of E_d = 3.0, 3.7, and 4.28 MeV. Proton-gamma angular correlations were measured leading to spin assignments of J = $\frac{3}{2}$, $\frac{5}{2}$, and $\frac{3}{2}$ for the first, second, and eighth excited states of ^{27}Mg at 0.984, 1.69, and 3.56 MeV, respectively, using plane-wave analysis. A similar analysis of the angular correlation of the 1.94-Mev gamma ray in coincidence with the protons leading to the third excited state led to a level spin preference of J = $\frac{5}{2}$ for this state, while the angular correlation of the 2.08-MeV gamma ray in coincidence with protons populating the unresolved ninth and tenth excited states at 3.76 and 3.78 MeV indicated that a J = $\frac{3}{2}$ assignment is favored for these combined levels. Branching ratios for the gamma rays proceeding from this doublet state were determined, confirming the ratios previously established. Rough limits were established for the multipole-mixing parameter δ of the different gamma rays studied. The relevance of the extreme single-particle collective model in the case of ^{27}Mg was investigated. Assuming that the last odd nucleon of ^{27}Mg occupies the Ω = $\frac{1}{2}$, Nilsson orbit 9; the K = $\frac{1}{2}$ band, based on the ground state, was observed to obey the level ordering predicted by the model provided that the 0.984- and the 1.94-MeV levels constitute the second and third members of this rotational band. This configuration yields a nuclear deformation parameter of η ~ 2, indicating a prolate spheroidicity for ^{27}Mg. The electromagnetic transition probabilities predicted by the model for the 0.984 → 0 gamma-ray transition, under such a configuration, agree remarkably well with the T(E-2)/T(M-1) ratio favored experimentally for this de-excitation. The level ordering chosen for the K = $\frac{1}{2}$ band based on the ground state leaves the 1.69-MeV state as the K = $\frac{5}{2}$ orbit 5 bandhead, conjectured to be a state formed by core excitation. The C^2 coefficients predicted by the model for the deformation favored are compared with the spectroscopic factors extracted by other investigators. (Diss. Abstr.)

19236 CROSS-SECTION MEASUREMENT OF THE THERMAL NEUTRON (n,α) REACTION IN ^{32}S AND ^{33}S. Harris, Jay Mark. University Park, Pa., Pennsylvania State Univ., 1966. 70p.

Thesis.

The (n,α) reaction, induced by thermal neutrons, was investigated in ^{32}S and ^{33}S. The ^{32}S(n,α)^{29}Si reaction was not observed; however, the data indicate that the value of the cross section is less than 6.8 mb. The cross section of the ^{33}S(n,α)^{30}Si reaction was measured to be 52 ± 16 mb. The experiment used a partially thermalized beam of reactor neutrons to bombard thin targets of natural sulfur and sulfur enriched in ^{33}S. A semiconductor detector was used to detect the emitted alpha particles. A large reduction in the recorded background radiation was achieved by using the target as the anode of an ionization chamber and recording only those pulses in the semiconductor detector that occurred simultaneously with a pulse in the ion chamber. This coincidence method required a minimum alpha particle energy of about 2 MeV for the system used and was successful only in the ^{33}S measurements. (Diss. Abstr.)

19237 MOESSBAUER EFFECT FOLLOWING COULOMB EXCITATION OF ^{57}Fe. Ritter, Enloe Thomas. Baltimore, Johns Hopkins Univ., 1966. 135p.

Thesis.

A new class of Mössbauer studies was carried out by use of a Van de Graaff accelerator. Mössbauer effect following Coulomb excitation of ^{57}Fe is studied for ^{57}Fe nuclei in metallic and Fe_2O_3 targets. It is found that within experimental error the Mössbauer f-value following Coulomb excitation in metallic iron is not reduced with respect to a ^{57}Co source in an α-iron lattice, whereas in the oxide data a reduction in f, with respect to a ^{57}Co source in an Fe_2O_3 lattice, of approximately a factor of two is observed. However, in both the metallic and oxide data the respective hyperfine splittings are the same within experimental error as the published values for metallic iron and Fe_2O_3. These results are interpreted in terms of extensive replacement collisions. These experiments demonstrate conclusively in the case of ^{57}Fe that the use of Coulomb excitation to populate low-lying levels for Mössbauer study is feasible. Insight into the recoil trajectory of the ^{57*}Fe gained from this work leads one to conclude that this technique is quite satisfactory for Mössbauer study of nuclides in a wide variety of close-packed lattices. (Diss. Abstr.)

19238 STUDY OF THE INELASTIC SCATTERING OF 42-MeV ALPHA PARTICLES FROM NUCLEI WITH 20 PROTONS OR 28 NEUTRONS. Peterson, Roy Jerome. Seattle, Univ. of Washington, 1966. 410p.

Thesis.

The utility and reliability of inelastic alpha particle scattering as a means for obtaining nuclear spectroscopic information is well known. Several models are available to describe the scattering process, including those based on the optical model, such as the method of coupled channels and the collective and single-particle DWBA, and those which rely upon the adiabatic approximation, sich as the Austern–Blair and Blair–Sharp–Wilets

models and the Fraunhofer approximation. In this thesis the assumptions and derivations of these models will be sketched, and extensive numerical comparisons of their predictions will be made. The great similarity between the various descriptions enhances the validity of the spin and parity assignments made using these models. Experimental studies of the elastic and inelastic scattering of 42-MeV alpha particles from ^{42}Ca, ^{44}Ca, ^{48}Ca, ^{51}V, ^{52}Cr, and ^{54}Fe were carried out. The elastic scattering cross sections are analyzed in terms of a smooth edge Fraunhofer model, a parameterized partial-wave analysis, and the optical model; all three models indicate that the increase in the nuclear radii as one progresses from ^{40}Ca to ^{54}Fe is much smaller than would be expected. The inelastic cross sections are analyzed, for the most part, in terms of the Austern–Blair adiabatic model. Good agreement between the observed and predicted angular distributions is typically found, allowing many spin-parity assignments to be made for the nuclear excited states. The spin-parity assignments of this work are in excellent agreement with those determined by other spectroscopic techniques. A systematic comparison of the spectra and transition strengths of the Z = 20 and N = 28 sequences to the predictions of several nuclear models provides some support to a simple version of the shell model, in which only f $_{7/2}$ orbitals are considered, especially if some collective quadrupole enhancements are included in that model. However, many more states are observed at relatively low excitation energies than are expected for any of the simple models. A more sophisticated shell model, which introduces a pairing-plus-multipole force between the nucleons, is also discussed and is applied to the experimental results. This model can reproduce the observed energies of the low-lying positive-parity states and the collective enhancement of the differential cross sections to the first 2^+ states. However, the predicted cross sections to the higher positive-parity states are much smaller than observed. (Dissertation Abstr.)

19239 DELAYED ALPHA-PARTICLE EMISSION FROM EXCITED STATES OF ^{20}Ne FOLLOWING BETA DECAY OF ^{20}Na. Polichar, Raulf Maurice. Los Angeles, Univ. of California, 1966. 109p.

Thesis.

The design and construction of a system for the study of short-lived heavy-particle radioactivity is described. The system was used to study the delayed alpha particles emitted from excited states of ^{20}Ne following their population by the beta decay of ^{20}Na. Seven alpha transitions were identified, and their properties were measured. These transitions arise from the 7.43, 7.84, 8.72, 9.50, 10.27, 10.84, and 11.27 MeV levels in ^{20}Ne. The results of this experiment are compared with recent data obtained from the direct positron decay of ^{20}Na, and a complete decay scheme is proposed. The results are compared to the predictions of the Nilsson rotational model. (Dissertation Abstr.)

19240 MOESSBAUER EFFECT OF THE SECOND EXCITED STATE OF ^{57}Fe. Hershkowitz, Noah. Baltimore, Johns Hopkins Univ., 1966. 121p.

Thesis.

The Mössbauer effect in the 136.4-keV decay of the second excited state of ^{57}Fe was observed. Partially resolved hyperfine structure was used to determine the magnetic moment of this level. A technique of observing the resonance absorption of recoilless gamma rays was developed in order to perform this experiment. This was necessary because the recoilless fraction and the absorption cross section for this transition were both as small, or smaller, than those of any transition that had previously been observed using the conventional techniques of Mössbauer spectroscopy. The basic technique used in this experiment was to determine that resonance absorption had occurred by observing the preferential decay of the 136.4-keV level by way of the first excited state. A broader version of this technique was shown to have applications to the general study of weak Mössbauer effects such as those observed in thin magnetic films. A 6-mg/cm^2 ^{57}Fe scatterer in which the 136-keV level is split by the magnetic hyperfine interaction, was used in all measurements. Both source and scatterer were cooled to liquid helium temperatures. The Mössbauer effect of the 136.4-keV level was unambiguously observed using 15 millicuries of ^{57}Co diffused into iron as a source. The recoilless fraction was approximately 2×10^{-3}. Magnetic hyperfine structure was observed using 15 mC of ^{57}Co diffused into palladium, which showed no hyperfine splitting. Since this structure was only partially resolved, the sign of the magnetic moment was not determined with certainty. However, the assumption that the magnetic moment is negative led to agreement with the magnitude of the magnetic moment previously reported by Körner. The magnetic moment determined was g = –.39 ± .04. (Dissertation Abstr.)

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Refer also to abstracts 17564, 17603, 17673, 18301, 19191, 19217, 19231, 19296, 19324, 19341, and 19455.

19241 (IDO–14681) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter April 1–June 30, 1966. Maeck, William J.; Rein, James E. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Feb. 1967. Contract AT(10-1)-205. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In this continuing program to develop methods for the accurate determination of burnup of nuclear fuels, the main emphasis was additional measurements of ^{233}U fission yields from the third and fourth irradiated capsules of ^{233}U. These capsules contained a weighed quantity of highly enriched ^{233}U. One capsule was irradiated to approximately 8 atom percent fission and the other to approximately 32 atom percent fission. The capsules were separately dissolved and analyzed for the number of atoms of each uranium isotope and for the number of atoms of many stable and long-lived fission product nuclides. The average absolute ^{233}U thermal fission yield values based on the analysis of these two capsules are given. (auth)

19242 (IN–1064) BURNUP DETERMINATION OF NUCLEAR FUELS. Project Report for the Quarter July 1–September 30, 1966. Lisman, Frederick L.; Maeck, William J.; Foster, Robert E. Jr.; Rein, James E. (Idaho Nuclear Corp., Idaho Falls). Mar. 1967. Contract AT(10-1)-1230. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

In a continuing program to develop methods for the accurate determination of the burnup of nuclear fuels, the main emphasis was the additional measurement of ^{235}U thermal fission yields for many stable and long-lived fission products and the development of an extraction, in-situ spectrophotometric method for the determination of the ^{99}Tc fission yields for ^{233}U and ^{235}U. A capsule containing a weighed quantity of highly enriched ^{235}U, irradiated to 31.6 atom percent fission, was dissolved and analyzed for the number of atoms of each uranium isotope and various stable and long-lived fission product nuclides. From these data, the capture-to-fission ratio (α) and absolute fission yields were determined. The value for α_0 is 0.1752 ± 0.0028. The absolute thermal fission yields of ^{99}Tc for ^{233}U and ^{235}U were determined on each of four previously dissolved ^{233}U capsules and three ^{235}U capsules. The ^{99}Tc was separated from the dissolved capsule solutions by extraction of the tetrapropylammonium pertechnetate ion-association complex and was determined spectrophotometrically as the Tc(V) thiocyanate complex. (auth)

19243 (JINR-E7–3160) EXCITATION ENERGY OF THE SPONTANEOUSLY FISSIONING ISOMERIC STATE IN ^{240}Am. Bernkhol'm, S.; Borgrin, I.; Vestgard, L.; Karnaukhov, V. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1967. 27p. Dep. mn.

The excitation function for the reaction ^{241}Pu(p,2n)^{240}Am leading to the spontaneous fissioning isomeric state in ^{240}Am was measured with proton energies of 9.6 to 13.6 MeV. The excitation function shows a typical threshold behavior corresponding to a threshold of 10 ± 0.1 MeV. This is 3.15 ± 0.25 MeV higher than the estimated threshold for the ground-state reaction, and it is interpreted as the excitation energy of the isomeric state. Possible reasons for the unusual stability towards γ emission of such a high-lying level are discussed. (auth)

19244 (KFK–451) MEASUREMENTS OF EFFECTIVE (RESONANCE-SHIELDED) NEUTRON CROSS-SECTIONS IN THE keV REGION. Miessner, H.; Arai, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Oct. 1966. 14p. (CONF-661014–45). Dep. mn.

From IAEA Conference on Nuclear Data, Paris, France.

The pulsed-neutron technique was used to measure capture and transport cross sections in Pb and ^{238}U in the keV energy range. In this method, a short burst of protons was produced by a pulsed 3-MeV Van de Graaff (pulse time 1 or 10 nsec, repetition rate 0.5 or 1 Mc/sec). The pulsed proton beam passes through an electrostatic pick-up system which provides the zero timing pulse. The ^{7}Li(p,n)^{7}Be reaction yields 30-keV neutrons near threshold (with energy spread of ±6 keV); the ^{45}Sc(p,n)^{45}Ti reaction was used to yield neutrons of 7.5 keV with an energy spread of ±0.8 keV at the lowest resonance of the (p,n) cross section. The short bursts of nearly monoenergetic neutrons with energies below the threshold for inelastic scattering were injected into blocks of Pb and ^{238}U, and the decay of the neutron field in the blocks was measured. For these heavy materials,

moderation effects are negligible so that the diffusion process can be described by one-group theory, and the neutron field decays exponentially. The effective cross sections of Pb and ^{238}U measured by this technique are tabulated. (S.F.L.)

19245 (ORO–2972–7) ISOBARIC ANALOGUE RESONANCES IN ELASTIC AND INELASTIC SCATTERING OF PROTONS ON ^{208}Pb. Technical Report No. 1. Parish, Leslie; Zaidi, S. A. A.; von Brentano, P.; Moore, C. Fred (Texas Univ., Austin). Sept. 1966. Contract AT(40-1)-2972. 65p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Isobaric analog resonances were observed in excitation curves for elastic and inelastic proton scattering on ^{208}Pb. The resonances were identified with the single-particle states in ^{209}Pb. The elastic scattering excitation functions were analyzed using a single level plus optical and Coulomb potential formula. Widths for the isobaric analog states were determined to be of the order of 300 keV. (S.F.L.)

19246 (UCRL–16969) I. THE MEASUREMENT OF INTERNAL CONVERSION COEFFICIENTS UTILIZING SEMICONDUCTOR DETECTORS. II. DECAY SCHEME STUDIES OF THE ODD-MASS GOLD ISOTOPES. Haverfield, Arthur Judd (California Univ., Berkeley. Lawrence Radiation Lab.). Nov. 10, 1966. Contract W-7405-eng-48. 196p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

The application of semiconductor detectors to measurements of internal conversion coefficients is extensively discussed, with particular emphasis being placed upon a spectrometer employing both Si(Li) and Ge(Li) detectors for the simultaneous observation of conversion electrons and gamma rays. The construction, calibration, and use of such a spectrometer are described. Possible improvements in this system are also discussed. It is found that this type of spectrometer is best suited for ICC measurements of transitions following electron-capture decay, but may still be useful in cases of beta or positron decay. The level schemes of the odd-mass Au isotopes of mass 199, 197, 195, and 193 were examined from the decay of the respective odd-mass platinum and mercury isotopes. The measurement of numerous internal conversion coefficients permitted the assignment of spin and parity values to many of these levels. The systematic trends of many of the nuclear phenomena associated with these isotopes were examined as a function of neutron number. The experimental data were compared to the various theoretical approaches applicable to this region of nuclei. The internal conversion process is discussed along with the various experimental methods of ICC measurement. The calibration of semiconductor detectors for energy and intensity measurements is discussed. Extensive tables of standards for these calibration procedures are presented. (auth)

19247 MEASUREMENT OF THE NUCLEAR MAGNETIC DIPOLE MOMENT OF ^{197}Au AND HYPERFINE STRUCTURE MEASUREMENTS IN THE GROUND STATES OF ^{197}Au, ^{107}Ag, ^{109}Ag, AND ^{39}K. Dahmen, H.; Penselin, S. (Univ., Heidelberg). Z. Phys., 200: 456-66(Mar. 14, 1967).

Using an atomic beam magnetic resonance apparatus, the nuclear magnetic dipole moment μ_I of the stable isotope ^{197}Au was measured directly with the doublet method. Further hyperfine structure measurements were performed in the ground states of ^{39}K, ^{107}Ag, ^{109}Ag, and ^{197}Au. (auth)

19248 NUCLEAR SPIN OF ^{249}Bk FROM THE HYPERFINE STRUCTURE IN ITS EMISSION SPECTRUM. Worden, Earl F. (Univ. of California, Livermore); Hulet, E. Kenneth; Lougheed, Ronald; Conway, John G. Contract W-7405-eng-48. J. Opt. Soc. Amer., 57: 550(Apr. 1967). (UCRL–70073).

The nuclear spin of ^{249}Bk was determined from the hyperfine structure in its high-resolution emission spectrum. The presence of a large number of lines with eight well-resolved components, the number of components being clearly spin-limited, definitely established the spin to be $7/2$. (D.C.W.)

19249 EFFECT OF PHYSICAL STATE ON THE DECAY OF ^{131}I AND ITS DAUGHTER. Bergamini, P. G.; Palmas, G.; Piantelli, F.; Rigato, M. (Univ., Siena, Italy). Phys. Rev. Lett., 18: 468(Mar. 20, 1967).

The decay of ^{131}I was measured by systematic detection of the gamma radiation emitted using several samples of NaI, some containing solid salt and others in solution at several concentrations. All the samples were measured every 12 hrs for a duration of time equal to six half lives. An accurate study of the results seems to indicate that the half life is longer for the samples in solution with respect to those in solid form. (S.F.L.)

19250 LIFETIMES OF 2^+ AND 4^+ STATES OF ^{160}Dy. Ayyangar, K. M. M. S.; Lakshminarayana, V.; Jnanananda, Swami (Andhra Univ., Waltair, India). Indian J. Phys., 40: 432-42 (July 1966).

The half lives of the first and second excited states of ^{160}Dy were measured by the delayed-coincidence method. For this measurement, a time-to-amplitude converter is assembled. With NaI(Tl) crystals on both the photomultipliers, a resolving time of 2.4 ns with an intrinsic time resolution of 0.27 ns was achieved down to an energy of 200 keV. The life-times of 2+ and 4+ levels of ^{160}Dy were obtained at $T(2+) = 1.94 \pm 0.097$ ns and $T_{\frac{1}{2}}(4+) = (11.25 \pm 1.13) \times 10^{-11}$ sec. These values confirm those obtained by Li and Schwarzchild. The results obtained are discussed and found to confirm the predictions of the unified nuclear model. (auth)

19251 PRECISION MEASUREMENTS ON THE 296 keV AND 316 keV TRANSITIONS IN ^{192}Pt. Karlsson, S. E.; Hoegberg, S.; Nilsson, Oe. (Uppsala Univ.). Phys. Lett., 24B: 148-50(Feb. 6, 1967).

A recently reported L_{II} anomaly in Pt is removed. Precise determinations of the energies of the 296-keV and 316-keV transitions are obtained. The L subshell ratios for the 316-keV E2 transition are measured. (auth)

19252 THE DECAY OF ^{94}Ru TO LEVELS IN ^{94}Tc. Eichler, E.; Chilosi, G.; Johnson, N. R. (Oak Ridge National Lab., Tenn.). Phys. Lett., 24B: 141-2(Feb. 6, 1967). (ORNL-P-2773).

The nucleus ^{94}Ru decays with a 53 min half-life by electron capture to states in ^{94}Tc at 474 and 998 keV which de-excite by emitting gamma rays with energies 367.2, 525, and 891.2 keV and relative intensities 100, 2, and 40. (auth)

19253 A CONTRIBUTION TO THE PROBLEM OF THE DISCREPANCY IN THE EXPERIMENTAL Q VALUES OF THE CAPTURE DECAY OF ^{204}Tl. Goudsmit, P. F. A.; Jansen, J. F. W.; Mijnheer, B. J.; Wapstra, A. H. (Instituut voor Kernphysisch Onderzoek, Amsterdam). Physica, 32: 2161-3(Nov.-Dec. 1966).

It is shown that measurements of inner bremsstrahlung in ^{204}Tl due to electron capture, in coincidence with Kx radiation, are too much hindered by secondary effects to allow a reasonable determination of the disintegration energy. The earlier ^{204}Tl results, deviating from those obtained in another way, should therefore be doubted. (auth)

19254 A CHAINS FOR HEAVY NUCLEI. PART I. $213 \leq A \leq 228$. Wapstra, A. H.; Gove, N. B. Nucl. Data, Sect. B, 1: B1.5.1.-130(Nov. 1966).

A compilation of information on the decay and quantum numbers of nuclei with $213 \leq A \leq 228$ is presented. (D.C.W.)

19255 SOME ACCURATE HALF-LIFE DETERMINATIONS. Middelboe, V. (Royal Veterinary and Agricultural Coll., Copenhagen). Kongel. Dan. Vidensk. Selsk., Mat.-Fys. Medd., 35: No. 8, 1-17(1966).

The rate of decay of three short-lived nuclides was reinvestigated, and improved half-life values were found. The results are as follows: ^{137m}Ba, 153.46 ± 0.20 sec; ^{109m}Ag, 39.80 ± 0.18 sec; and ^{106}Rh, 30.35 ± 0.15 sec. The standard deviations include the uncertainties involved in the investigations of radioactive impurities. (auth)

19256 FINE STRUCTURE IN THE ALPHA DECAY OF THERMAL NEUTRON CAPTURE STATES OF ^{150}Sm. Oakey, N. S.; McFarlane, R. D. (McMaster Univ., Hamilton, Ont.). Phys. Lett., 24B: 142-4(Feb. 6, 1967).

Alpha decay was observed from the thermal neutron capture states of ^{150}Sm to 10 states of ^{146}Nd up to 2 MeV. Most of the transitions to the quadrupole and octupole bands have approximately constant reduced widths. (auth)

19257 A TEST OF SCREENING CORRECTIONS FOR M-SUBSHELL INTERNAL CONVERSION COEFFICIENTS. Dragoun, O.; Jahn, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Phys. Lett., 24B: 146-7(Feb. 6, 1967).

Experimental M-subshell internal conversion coefficients for five E2 transitions (four in ^{192}Pt and one in ^{76}As) are compared with theoretical values based on different screening corrections. (auth)

19258 SOME FEATURES OF THE FRAGMENTATION OF HEAVY EMULSION NUCLEI. Catala, J.; Gil, D.; Senent, F.; Tarrega, P.; Villar, E. (Instituto de Fisica Corpuscular, Valencia). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 55-7(Jan.-Feb. 1967).

Complete energy spectra for differently charged particles present two peaks (A and B) for each value of Z. Phenomenological differences between A and B-particles are presented. Consequences of this classification are discussed assuming that the emission mechanism is independent of the charge. (auth)

19259 RESIDUAL NUCLEI PRODUCED IN HIGH-ENERGY INTERACTIONS WITH HEAVY EMULSION NUCLEI. Doporto, M. P.; Gil, D.; Llosa, R.; Senent, F.; Tarrega, F.; Villar, E.

(Instituto de Fisica Corpuscular, Valencia). An. Real Soc. Espan. Fis. Quim. (Madrid), Ser. A, 63: 51-3(Jan.-Feb. 1967).

Based on a phenomenological definition of recoil tracks in emulsion interactions, experimental evidence is presented which suggests that the recoil range is independent of, whereas the rate of the F/B with the incident momentum depends on, the nature of the incident particle. (auth)

19260 ISOMERIC STATES IN THE 3 TO 500 NANOSECOND RANGE POPULATED BY (α,xn) REACTIONS. Yamazaki, T.; Ewan, G. T. (Univ. of California, Berkeley). Phys. Lett., 24B: 278-80(Mar. 20, 1967).

Isomeric states in the 3 to 500 nanosecond range were measured by a new method depending on the fast timing properties of Ge(Li) detectors and the small time spread of beam bunches in a sector-focussed cyclotron. Previously unreported isomeric transitions are reported in ^{208}Po and ^{210}Po. (auth)

19261 HYPERFINE STRUCTURE ANOMALY OF THE STABLE YTTERBIUM ISOTOPES. Budick, B.; Snir, J. (Hebrew Univ., Jerusalem). Phys. Lett., 24B: 276-7(Mar. 20, 1967).

A level-crossing experiment was performed in the excited $^3P_1$ state in each of the stable ytterbium isotopes. Precise values for the magnetic hyperfine structure constants have made possible a deduction of the hyperfine structure anomaly. The value obtained is $\Delta = -0.344 \pm 0.020\%$. (auth)

19262 HALF-LIFE OF ^{109}Ru. Griffiths, K.; Fritze, K. (McMaster Univ., Hamilton, Ont.). Z. Anal. Chem., 226: 122-4 (1967).

The half life of ^{109}Ru produced in the reactor irradiation of $UO_2(NO_3)_2 \cdot 6H_2O$ was measured to be 34.5 ± 2.4 sec using the distillation of RuO_4 from boiling perchloric acid. (D.C.W.)

19263 NUCLEAR PROPERTIES OF ^{251}Bk. Diamond, H.; Sjoblom, R. K.; Barnes, R. F.; Lerner, J. L.; Henderson, D. J.; Fields, P. R. (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 29: 601-4(Mar. 1967).

A new isotope, ^{251}Bk, was isolated and was found to decay by β^- emission with a half life of 57.0 ± 1.7 min. Gamma rays of 34 and 140 keV were observed, and 94- and 184-keV gamma rays are probably present. The apparent absence of observable gamma rays at 58.5 and 81 keV indicates that the ground state of ^{251}Bk is probably not $7/2^+$ as might be expected from analogy with ^{249}Bk. (auth)

19264 SMALL ANGLE ELASTIC SCATTERING OF POLARIZED 4-MeV NEUTRONS BY MEDIUM AND HEAVY NUCLEI. Gorlov, G. V.; Lebedeva, N. S.; Morozov, V. M. JETP Lett. (USSR) (Engl. Transl.), 5: 106-7(Feb. 15, 1967).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 5: 131-3(Feb. 15, 1967).

Differential cross sections for the elastic scattering of polarized 4-MeV neutrons by Bi, Cu, In, Pb, Sn, and U at 2 to 21° were measured. It was observed that the differential cross sections have an appreciable rise at $\theta = 2°$ and that in scattering through angles $\theta \leq 6°$ the polarization is appreciable and increases with decreasing scattering angle. The form of the differential cross sections can be well described in terms of only nuclear and Coulomb scattering. (D.C.W.)

19265 NEWLY OBSERVED GAMMA TRANSITIONS IN ^{151}Tb AND ^{152}Tb DECAY. Kormicki, J. (Inst. of Nuclear Physics, Krakow); Niewodniczanski, H.; Stachura, Z.; Zuber, K.; Budziak, A. Acta Phys. Pol., 31: 317-32(Feb. 1967).

The internal conversion electron spectrum of the decays of ^{151}Tb and ^{152}Tb in the energy region from 30 keV to 600 keV was measured with the aid of a semicircular beta spectrograph. The activities were produced by spallation of Ta nuclei with 660-MeV protons. The energies and relative intensities of conversion lines were measured. For some transitions their multipolarities and mixing ratios were also determined. Twelve gamma transitions in ^{151}Gd and ^{152}Gd nuclei based on a number of newly observed conversion lines in the ^{151}Tb and ^{152}Tb decays were determined for the first time. (auth)

19266 COULOMB EXCITATION OF ^{189}Os NUCLEUS. Hryniewicz, A. Z.; Sawicka, B.; Styczen, J.; Szymczyk, S.; Szawlowski, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 31: 437-40(Feb. 1967).

Gamma spectra from the Coulomb excitation of ^{189}Os by 52-MeV ^{12}C ions were measured, and transition probabilities for states in ^{189}Os were determined. (D.C.W.)

19267 SYSTEMATICS OF SOME NUCLEON TRANSFER REACTIONS OF COMPLEX NUCLEI. Strudler, P. M.; Preiss, I. L.; Wolfgang, Richard (Yale Univ., New Haven). Phys. Rev., 154: 1126-35(Feb. 20, 1967).

Nucleon transfer reactions between ^{115}In and ^{14}N and ^{12}C projectiles were studied at energies up to 10.5 MeV/amu. Radiochemical techniques were used to characterize products resulting from nucleon loss or gain by the target nucleus. Three types of measurements were made: excitation functions; recoil range distributions in the forward direction, by use of stacks of thin catcher foils; and average recoil ranges in the forward direction, using thick catcher foils. The recoil measurements provide a clear distinction between transfer and mechanisms involving evaporation from a compound nucleus formed by complete fusion of target and projectile (CFCN). Cross sections are appreciable for transfer of several nucleons, including protons, to the target nucleus. By contrast, reactions in which two protons are lost by the target were not found, although there is considerable probability for loss of as many as five neutrons. A general trend favoring neutron-deficient species is consistent with some secondary neutron evaporation from more highly excited products of primary transfer events. The data indicate that a considerable diversity of transfer reactions occur with appreciable cross section. They thus complement earlier work in which products derived from the projectile were studied. Results are consistent with a concept of grazing reactions in which the Coulomb barrier is penetrated without formation of a compound nucleus by fusion of the reaction partners. The energy dependence of the recoil range of single-nucleon transfer products accords closely with a simple quasi-elastic collision model. Modification of this model to take mass transfer into account can approximate the recoil behavior of multinucleon pickup products. However, a detailed understanding of multinucleon transfer in grazing reactions is still lacking. (auth)

19268 DECAY OF ^{95}Y. Van Klinken, J.; Taff, L. M.; Eakins, G. W.; Bureau, A. J.; Hatch, E. N. (Ames Lab., Ames, Iowa). Phys. Rev., 154: 1116-25(Feb. 20, 1967). (IS-1409).

The decay of ^{95}Y was investigated with semiconductor and scintillation spectrometers. The half life of this isotope was measured to be 10.7 ± 0.2 min. Its total disintegration energy is 4.43 ± 0.02 MeV. The beta decay to the ground state of ^{95}Zr (82% of the total decay) is expected to be unique first-forbidden. However, the log f_1t value of 7.45 is very low for this type of beta transition. Furthermore, the typical unique first-forbidden shape was not confirmed. The other β-ray branches excite a complex system of more than 20 levels in ^{95}Zr, with γ-ray energies up to 4 MeV. The lower levels of this scheme agree with those observed by Cohen and Chubinsky with the ^{94}Zr(d,p) reaction. Using their spin assignments for the lower levels, it was possible to suggest spins and parities of some higher energy levels. Some remarks on the decay of ^{94}Y, a source contaminant, and on the decay of ^{38}Cl, an isotope used for calibration purposes, are included. (auth)

19269 RADIATIVE TRANSITIONS IN ^{207}Pb AND ^{208}Pb FOLLOWING RESONANCE NEUTRON CAPTURE IN ^{206}Pb AND ^{207}Pb. Biggerstaff, J. A.; Bird, J. R.; Gibbons, J. H.; Good, W. M. (Oak Ridge National Lab., Tenn.). Phys. Rev., 154: 1136-41(Feb. 20, 1967). (ORNL-P-2475).

Measurements were made of the spectra of gamma rays that are emitted when neutrons of various energies below 100 keV are captured in ^{206}Pb and ^{207}Pb. Capture resonances were observed, and gamma-ray de-excitation takes place primarily to the $1/2^-$, $5/2^-$, and $3/2^-$ levels in ^{207}Pb, and to the 0^+ and 3^- levels in ^{208}Pb. A few other weaker transitions are seen in ^{207}Pb to unidentified levels. It is possible to make plausible spin and parity assignments to the resonant states by combining these results with earlier measurements of total and capture cross sections. The measurements collectively indicate a predominance of negative-parity capturing states in ^{207}Pb and positive-parity capturing states in ^{208}Pb. The positive-parity resonances in ^{208}Pb decay predominantly through the 3^- state at 2.61 MeV, and the 1^- neutron capture decays directly to ground. (auth)

19270 NUCLEAR MAGNETIC MOMENT, HYPERFINE STRUCTURE, AND HYPERFINE-STRUCTURE ANOMALY OF ^{110m}Ag. Schmelling, Stephen G.; Ehlers, Vernon J.; Shugart, Howard A. (Univ. of California, Berkeley). Phys. Rev., 154: 1142-5(Feb. 20, 1967). (UCRL-17012).

The atomic-beam magnetic-resonance technique was used to measure the free-atom ground-state hyperfine structure separation $\Delta\nu$, the nuclear magnetic moment μ_I, and the hyperfine-structure anomaly $^{109}\Delta^{110m}$ of 260-day ^{110m}Ag (I = 6). The magnetic moment μ_I was obtained independently of $\Delta\nu$ by observing a $\Delta F = \pm 1$ doublet at its field-independent point. The results are $\Delta\nu$ (^{110m}Ag) = +30313.756(4) MHz, μ_I (^{110m}Ag) (uncorr) = +3.587(4) nm, and $^{109}\Delta^{110m} = -2.47(12)\%$. The results are shown to fit in well with existing theories. (auth)

19271 NUCLEAR LEVELS IN ^{163}Dy. Schult, O. W. B. (Technical Univ., Munich. Florida State Univ., Tallahassee); Bunker, M. E.; Hafemeister, D. W.; (and others). Phys. Rev., 154: 1146-73(Feb. 20, 1967). (LA-DC-8030).

Nuclear levels of ^{163}Dy were investigated, combining the follow-

ing experimental techniques: the measurement of low-energy (n,γ) radiation between 30 keV and ≈1.2 MeV using a curved-crystal spectrometer, the measurement of (n,e⁻) conversion electrons in the energy range between 113 and 950 keV with a double-focusing β spectrometer, the investigation of high-energy (n,γ) transitions between 4 and 6.4 MeV using a Ge(Li) spectrometer, and the study of (d,p) and (d,t) reactions utilizing 12-MeV deuterons and a broad-range magnetic spectrograph. The observed levels are: the [523↓] ground-state rotational band, including the rotational states $\frac{7}{2}^-$, $\frac{9}{2}^-$, and $\frac{11}{2}^-$; the first 4 members of the [642↑] band, with the $\frac{5}{2}^+$ band head at 250.9 keV; the [521↓] band, including the members $\frac{1}{2}^-$ (at 351.1 keV), $\frac{3}{2}^-$, $\frac{5}{2}^-$, and $\frac{7}{2}^-$; the lowest 4 members of the [521↑] band, with the $\frac{3}{2}^-$ state at 421.8 keV; the $\frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{5}{2}^+$ levels of a $K^\pi = \frac{1}{2}^+$ band based at 737.6 keV, believed to be mainly a mixture of the vibrational configuration {[642↑], K−2} and [660]; another $K^\pi = \frac{1}{2}^+$ band based at 884.3 keV, including the $\frac{1}{2}^+$, $\frac{3}{2}^+$, and $\frac{5}{2}^+$ states, assigned as mainly a three-quasiparticle configuration; a state at 820.8 keV, assigned as the head of a $K^\pi = \frac{3}{2}^-$ band, probably of vibrational character; a state at 859.3 keV, assigned as the head of a $K^\pi = \frac{3}{2}^+$ band; an $I^\pi = \frac{3}{2}^-$ level at 1049.1 keV; and an $I^\pi = \frac{1}{2}^-$ state at 1055.7 keV. In addition, the $\frac{7}{2}^-$ rotational level of the [512↑] band is probably at 799.5 keV, the $\frac{3}{2}^-$ state of the [510] band is indicated at 1200 keV, and a further state, probably of low spin, was observed at 1058 keV. A number of other unassigned levels were found in the (d,p), (d,t), and high-energy (n,γ) experiments. Essentially all states above 350 keV appear to be of mixed character, and several of the indicated "single-particle" bands are believed to have sizable vibrational components. Many of the γ-ray branching ratios among the three lowest negative-parity bands are anomalous, and the extent to which these deviations can be explained in terms of Coriolis coupling was investigated. (auth)

19272 LIGHT CHARGED PARTICLES FROM SPONTANEOUS FISSION OF ^{252}Cf. Whetstone, S. L. Jr. (Los Alamos Scientific Lab., N. Mex.); Thomas, T. D. Phys. Rev., 154: 1174-81(Feb. 20, 1967). (LA-DC-8204).

A semiconductor ΔE-E counter telescope was used to identify light charged particles spontaneously emitted from ^{252}Cf. From the measured partial-energy spectra of the particles, it was possible to estimate by extrapolation the following total yields of the various particle types observed. The ^{1}H energy spectrum is qualitatively different from the spectra of the other particles in that it contains a large component that appears to increase greatly with decrease in energy at the lowest energies. The smaller component that remains after subtraction of this apparent background is denoted (^{1}H), and it is speculated that these are the "scisson" protons. The yields were all obtained relative to the ^{4}He yield, the value for which was taken from Thomas and Whetstone. The energy spectra of (^{1}H), ^{2}H, ^{3}H, ^{3}He, ^{4}He, ^{6}He, and ^{8}He were found to have maxima at 9 ± 2, 7 ± 2, 8 ± 1, 17 ± 1, 16 ± 0.5, 13 ± 1, and ≲13 MeV and full widths at half-maximum of 6 ± 2, 7 ± 1, 6 ± 1, 9.5 ± 0.5, 11.5 ± 0.5, 8 ± 1, and 8 ± 4, respectively. The yields correlate more or less as expected with Halpern's estimates of the energy required for release of the particles into the region between the fission fragments, and the dependence of the energy spectra on mass can be understood in terms of the Halpern model. (auth)

19273 COULOMB EXCITATION OF ^{99}Ru AND ^{101}Ru. Kistner, O. C.; Schwarzschild, A. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 154: 1182-92(Feb. 20, 1967). (BNL-10468).

The gamma spectra resulting from Coulomb excitation of ^{99}Ru and ^{101}Ru by 4 to 7 MeV α particles are reported. Gamma spectra were investigated using both Ge(Li) detectors and NaI(Tl) detectors. More than 14 transitions in ^{99}Ru and 21 transitions in ^{101}Ru were observed. B(E2) values are presented for 7 states in ^{99}Ru and 10 states in ^{101}Ru. In addition, transition speeds are presented for several M1 and E2 transitions between excited states of these nuclei. The level schemes constructed for both nuclei are essentially in agreement with previous studies of radioactive decay. Many of the E2 transitions in both nuclei are very much enhanced, indicative of the collective character of the states. The transition speeds are compared with various nuclear-model predictions. (auth)

19274 LONG-RANGE PARTICLES OF Z = 1 TO 4 EMITTED DURING THE SPONTANEOUS FISSION OF ^{252}Cf. Cosper, S. W.; Cerny, J.; Gatti, R. C. (Univ. of California, Berkeley). Phys. Rev., 154: 1193-1206(Feb. 20, 1967).

The long-range particles emitted during the spontaneous fission of ^{252}Cf were investigated, confirming the emission of ^{1}H, ^{2}H, ^{3}H, ^{3}He, ^{4}He, and ^{6}He. In addition it was found that ^{8}He, ^{9}Li, ^{7}Li, ^{8}Li, ^{9}Li, ^{9}Be, ^{10}Be, and probably other isotopes of Be are also emitted. A detailed search for the emission of the heavy helium isotopes ^{7}He, ^{9}He, and ^{10}He yielded no evidence for their particle stability. Relative intensities and most probable energies for all emitted hydrogen and helium isotopes (except ^{3}He) and for the Li and Be ions were obtained. (auth)

19275 NEUTRON-INDUCED RESONANCE FISSION CROSS SECTION OF ^{238}Pu. Stubbins, Warren Fenton (Univ. of Cincinnati); Bowman, Charles D.; Auchampaugh, George F.; Coops, Melvin S. Phys. Rev., 154: 1111-15(Feb. 20, 1967). (UCRL-70033).

The neutron-induced fission cross section of ^{238}Pu was measured from 2 to 300 eV. Fission fragments were detected with a corona spark chamber. The data were normalized by extending the measurements into the MeV region, where the cross section is known. The fission components of the resonance cross section are roughly ten times the upper limits set from earlier work. A value for $\langle\Gamma_f/D\rangle = 0.77 \times 10^{-3}$ was obtained. This value is compared with predictions from fast-neutron-induced fission. (auth)

19276 ANGULAR AND ENERGY DISTRIBUTION OF NEUTRONS FROM ^{235}U FISSION. Kluge, Gyula; Lajtai, Albert; Nagy, Laszlo. KFKI (Kozp. Fiz. Kut. Int.) Kozlem., 14: 359-67(1966). (In Hungarian).

The energy distribution of neutrons produced by the thermal-neutron-induced fission of ^{235}U, measured at various angles relative to the direction of outflying fission fragments, is reported. The results of the measurements are compared with the isotropic evaporation spectrum in the fission-fragment system transformed to the laboratory system. (auth)

19277 FISSION CHANNEL WIDTH DEPENDENCE ON THE EXCITATION ENERGY OF NUCLEI. Vorotnikov, P. E. Yadern. Fiz., 4: 1259-60(Dec. 1966). (In Russian).

The probability of the fission of heavy (Z ≥ 90) nuclei upon excitation at several MeV above the ground state depends on the ratio of the width of the fission channel and the sum of the corresponding value of competing reactions which in this energy range are probably limited to the emission of neutrons or γ quanta. Previous theories which were used to explain observations in cases such as the fission of ^{230}Th by neutrons or the photofission of ^{232}Th were not found to be completely satisfactory. Two explanations are proposed: one is based on the assumption that there is a quasistable state of the nucleus deformed close to the so-called saddle point, possessing a lifetime of $<10^{-20}$ sec. The second explanation is related to the one-particle levels in the deformed nucleus. Thus, the study of the quantum characteristics of nuclei undergoing fission represents a method to determine the nucleon energy levels and their transition probabilities in deformed nuclei. (TTT)

19278 SYNTHESIS AND DETERMINATION OF RADIOACTIVE PROPERTIES OF SOME ISOTOPES OF FERMIUM. Akapev, G. N.; Demin, A. G.; Druin, V. A.; Imaev, E. G.; Kolesov, I. V.; Lobanov, Yu. V.; Pashchenko, L. P. At. Energ. (USSR), 21: 243-6(Oct. 1966). (In Russian).

The alpha decay of neutron-deficient fermium isotopes was studied using ^{238}U and ^{235}U isotopes irradiated by ^{16}O ions accelerated in the internal beam of the 310-cm cyclotron. The products of the nuclear reactions were collected by means of adsorption on a gas jet, and α decay was recorded with a (Si + Au) detector. Excitation functions of (^{16}O + n) reactions were studied, and alpha energies and half lives of fermium isotopes with mass numbers of 250, 249, 248, and 246 were found. (R.V.J.)

19279 SEMI-STATISTICAL METHOD OF EFFECTIVE DELAYED NEUTRONS FRACTION MEASUREMENT. Mogil'ner, A. I.; Krivelev, G. P.; Malyshev, E. K.; Morozov, S. A.; Shvetsov, D. M. At. Energ. (USSR), 22: 46-9(Jan. 1967). (In Russian).

The effective fraction, β_{eff} of the delayed neutrons is usually given in the relative form $\gamma = \beta_{eff}/\beta$ for a known value of β. However, the delayed neutron spectra are not sufficiently well known to calculate the value of γ, especially for Be or heavy-water-moderated reactors, in which the (n,2n) reaction exerts a strong influence on the delayed-neutron fraction. An experimental method was therefore developed for the determination of β_{eff} on the basis of an exact monoenergetic reactor model, maintaining a strict proportionality between the ionization current and the neutron flux. The error analysis indicated that the relative subcriticality is only slightly affected if $1 - k_{eff} \ll \beta_{eff}$. On the basis of 3 series of tests at various subcritical states, the value of β_{eff} was found to be 0.74×10^{-2}. The method is considered to be more generally applicable than that based on the substitution of the fissionable material with an equivalent amount of an absorber. (TTT)

19280 ABSOLUTE DETERMINATION OF FISSION FRAGMENT EMISSION RATES USING A PROMPT NEUTRON-FISSION COINCIDENCE METHOD. Porges, K. G.; De Volpi, A. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/55, 16p. (CONF-661012-41). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

Many of the basic parameters of the fission process have been remeasured in recent years with increasing precision. One piece of information required in some of this work, particularly for $\bar{\nu}$ and σ_f, is precise knowledge of the emission rate of a spontaneous fission source for calibration of a fission fragment detector. The count rate delivered by such a fission counter depends on the thickness and quality of the deposit, as well as bias of the discriminator. At any given bias a certain number of fission events results in tracks nearly in the plane of the coating, thus leaving insufficient energy in the detection medium to yield a scintillation or ionization pulse above bias. These problems are accentuated when very high fission rates, hence thick coatings and wide bandwidth electronics, are required. Potentially the most precise method of calibration leans upon experience gained in beta-gamma coincidence work, where similar problems of deposit thickness have been resolved. A method of neutron-fission prompt coincidence is adopted which emphasizes selection of an optimum geometry, and careful examination of sources of error in coincidence calibration. Since there is a rather strong fragment-neutron correlation in the direction of emission, it was found that a hemispherical counter geometry offers the best theoretical possibility of minimizing corrections, subject to uniformity of coating and uniformity of beam. It is difficult in a beam-type experiment in which ^{235}U fission is induced by thermal neutrons to provide a true 4π neutron detector. Because of the strong correlation in angle, the tendency of most experimenters to use a parallel plate counter perpendicular to the beam and neutron detector excluding the beam may have been responsible for some notable discrepancies revealed in a recent study by the IAEA of $\bar{\nu}$ for ^{235}U and ^{252}Cf and σ_f 2200 m/s values for ^{235}U. The discrepancies amount to 1 or 2 percent between the measured values and the least-squares fit of 10 parameters. The solution to this dilemma, besides counter construction in hemispherical geometry, was to conduct angular traverses where possible. For ^{252}Cf, even for so-called weightless deposits, significant azimuthal deviations are obtained. Several procedures for treating the data with a Legendre series expansion are developed. Apparatus involved in this calibration of rates exceeding 10^5 fissions/sec include fast response ionization counters, 100 MHz bandwidth electronic equipment, and a Hornyak button prompt neutron detector. Data are treated by the COINC computer code. (auth)

19281 ABSOLUTE CALIBRATIONS OF FISSION NEUTRON SOURCE STRENGTH RELYING UPON AN IMPROVED MANGANESE BATH TECHNIQUE AND ABSOLUTE BETA-GAMMA COINCIDENCE COUNTING. De Volpi, A.; Porges, K. G.; Armani, R. J. (Argonne National Lab., Ill.). Vienna, International Atomic Energy Agency, 1966, Preprint No. SM-79/56, 12p. (CONF-661012-34). DTIE.

From IAEA Symposium on the Standardization of Radionuclides, Vienna.

An experiment is described for measurement of the neutron yield in fission of ^{235}U and ^{252}Cf which is based upon the manganese bath technique for neutron source assay and relative gamma-gamma and absolute beta-gamma coincidence counting of induced ^{56}Mn activity. For thermal-neutron induced fission of ^{235}U, the manganese bath must be modified to contain a through-hole for passage of the neutron beam from a reactor. A fission counter, for which efficiency is calibrated in a separate experiment, is located at the center of the manganese bath sphere. Because of high reactor background, samples of the solution are withdrawn periodically and counted elsewhere directly in a gamma-gamma coincidence system which accepts two liters of activated liquid. The gamma-gamma high-stability high-efficiency liquid counter is frequently calibrated with an absolute beta-gamma coincidence arrangement. Over 300 such intercomparisons indicate that long-term stability is in the order of or better than 0.4%. The beta-gamma system consists of a room-temperature, two-phototube, low-noise, liquid scintillation beta counter and a sodium iodide gamma crystal. Verification of the coincidence result was carried out by a variety of methods, including a large number of comparisons involving different radionuclides with 4π beta proportional counters from the two laboratories at Argonne, and also to some extent against ^{56}Mn calibrations by two national laboratories. In addition, the neutron source strength of the U. S. National Bureau of Standards secondary standard was determined with a precision of 0.7% which is in good agreement with established values. An important adjunct to the absolute standardization of ^{56}Mn activity is the use of the computer code COINC specifically designed for reduction of coincidence counting data. This program embodies most of the features which one might desire in correction of coincidence data, accounting for deadtimes, resolving time, decay during counting, background, and computation of efficiencies and standard errors; it can be used with either manual or automatic transcription of data obtained for any isotope. It has been advocated that the code COINC be considered as a basis for standardization in computation of correction factors in coincidence counting. (auth)

19282 INVESTIGATION OF THE NEUTRON CAPTURE MECHANISM IN GOLD. Wetzel, Karl Joseph. New Haven, Yale Univ., 1965. 186p.

Thesis.

A single lithium-drift germanium detector was used to measure the high-energy gamma rays emitted following neutron capture in ^{197}Au with ~20-keV resolution. Using the time-of-flight method with a pulsed source of photoneutrons, the desired neutron energies were selected; gamma spectra were recorded following capture of thermal neutrons and following capture of neutrons in the 4.9-eV resonance. These high-resolution measurements define twenty-four gamma transitions previously unresolved in the energy range $E_\gamma \geq 5.08$ MeV. The absolute transition intensities and corresponding excitation energies in the final nucleus ^{198}Au are given. The fractional peak areas of each transition relative to the summed areas of all peaks in the high energy region ($E_\gamma > 5.95$ MeV) are calculated for both capturing conditions. A comparison of these quantities indicates that there are no significant changes in intensity of individual transitions within the summed groups between the resonance and non-resonance capturing conditions. Based on the conclusions of the previous Yale and the Russian measurements that no resonance-potential interference can be detected in the radiative capture cross section for various groups of high-energy gamma rays, the present measurements give further evidence for the lack of single-particle, direct-interaction processes in capture to low-lying final states. Within the framework of the Lane–Lynn formalism an explanation of the anomalously intense high-energy gamma rays in gold does not exist. A brief report of a supplementary deuteron stripping reaction in gold is given. A complete comparison of (d,p) final-state reduced widths with reduced (n,γ) intensities was not possible. For the ground-state transitions, where a comparison was possible, a small (d,p) reduced width is obtained; this is further evidence for the lack of single-particle character of this level. (Dissertation Abstr.)

19283 DOUBLY CHARGED PARTICLE EMISSION DURING NUCLEAR FISSION AT MODERATE EXCITATION ENERGIES. Loveland, Walter David. Seattle, Univ. of Washington, 1966. 127p.

Thesis.

The results of an experimental study of doubly charged particle emission in fissioning systems at moderate excitation energies (~10 to 40 MeV) are presented. (TSS)

19284 PHOTONEUTRON CROSS SECTION MEASUREMENTS ON ^{194}Pt, ^{195}Pt, ^{196}Pt, AND ^{198}Pt. Hege, Edgar Keith. Troy, N. Y., Rensselaer Polytechnic Inst., 1965. 211p.

Thesis.

Photoneutron yields from samples enriched in ^{194}Pt, ^{195}Pt, ^{196}Pt, and ^{198}Pt were measured from 5.8 to 24.0 MeV using bremsstrahlung from the Rensselaer Betatron. Photoneutron yields for the individual isotopes are deduced from these mixed yields. Two techniques for deducing photoneutron production cross sections from bremsstrahlung-produced yield curves are compared: the Penfold–Leiss total photon spectrum matrix inversion method and the Cook least structure analysis. The least structure technique gives considerably smoothed cross sections which are consistent with the cross sections obtained by the matrix inversion method. An attempt is made to identify details of the shape of the cross sections with components of vibration of a nuclear fluid with spheroidal or ellipsoidal boundaries. The observed cross sections can be accounted for by assuming a prolate spheroidal nuclear system. From the difference in energies of excitation of the non-degenerate longitudinal mode of vibration and doubly degenerate transverse mode, intrinsic quadrupole moments for the even mass nuclides are calculated. The mass number dependence of the quadrupole moments of the isotopes is in qualitative agreement with that predicted on the basis of a collective model interpretation of the low-lying rotation-vibration spectra of these isotopes. However, the odd isotope ^{195}Pt does not fit this scheme. The yield data also allow determination of the (γ,n) thresholds for the isotopes. These agree well with those calculated from other data. (Dissertation Abstr.)

19285 EXPERIMENTAL INVESTIGATION OF SOME NEUTRON-DEFICIENT NUCLEI. Evans, James Stuart. Princeton, N. J., Princeton Univ., 1966. 271p.

Thesis.

A windowless flow-type proportional counter was used to detect the 1.5-keV M x rays and Auger electrons emitted following the decay of ^{163}Ho by orbital electron capture from the atomic M shell. A preliminary value of 33 ± 23 yr was obtained for the half life of ^{163}Ho, in agreement with the allowed, unhindered character predicted for this beta process by the Nilsson strong-coupling model.

A six-gap electron spectrometer was adjusted and calibrated for use in beta-ray and conversion-electron studies. This spectrometer includes an air lock for inserting sources rapidly without admitting air to the vacuum chamber. A coincidence detection system with two photomultiplier tubes viewing a single plastic scintillator was developed in order to eliminate completely the background caused by thermal photomultiplier-tube noise. This low-background detection system makes possible the investigation of long-lived sources having low disintegration rates. Because of its high transmission and moderate resolution, the spectrometer is ideally suited for coincidence studies in which a conversion line is used to gate a gamma-ray coincidence spectrum. The spectrometer was used both for recording conversion-electron spectra and for obtaining conversion-electron–gamma coincidence spectra in studies of some palladium and rhodium isotopes. Using a time-to-amplitude converter, the half life of the 75-keV state in ^{100}Rh was measured to be 235 ± 3 nsec. The g-factor of this same state was determined by the time-differential angular correlation method to be +2.13 ± 0.03. A method for rapidly dissolving bulk rhodium metal was devised. The rhodium is fused with molten zinc to form a rhodium–zinc alloy, which is then converted to a water-soluble form by a second fusion with potassium hydrogen sulfate. Carrier-free radiochemical procedures are described for preparing sources of palladium and rhodium species. A general survey of the mass-100 region was made using the spherical shell model as a guide. The systematics of the single-particle proton and neutron states, $39 \leq Z \leq 49$ and $51 \leq N \leq 81$, were used to correlate existing data in odd-A nuclei and to suggest where to look for additional states which have not yet been located. The collective states in both even-even and odd-A nuclei were found to agree fairly well with the model of collective vibrations about a spherical equilibrium shape. The Brennan–Bernstein coupling rules were used to correlate the spins and magnetic moments of levels in odd-odd nuclei with those for levels in adjacent odd-A nuclei. The nuclei near mass 100 were compared with nuclei at the beginning and end of the deformed rare-earth region, in order to look for possible nonspherical equilibrium shapes. Several experimental criteria for distinguishing between the spherical and spheroidal shapes are discussed and are applied to the ruthenium and palladium isotopes. Although the well-studied nuclides seem to be adequately described by the spherical approximation, it is pointed out that spheroidal shapes might be encountered for ^{106}Ru and ^{114}Pd. (Dissertation Abstr.)

19286 GAMMA-RAY SPECTRA OF FISSION PRODUCTS FROM ^{235}U AS A FUNCTION OF TIME AFTER FISSION. Boggs, John Vincent. Norman, Okla., Univ. of Oklahoma, 1966. 105p.

Thesis.

Until recently gamma spectroscopy was performed using NaI(Tl) crystals and cumbersome Compton spectrometers. With the advent of high-resolution solid-state detectors, gamma energies can be determined with a high degree of precision. These detectors have the ability to resolve gamma rays in very complicated spectra such as the fission-product gamma spectra at short times after fission. A fast pneumatic transfer system was designed and built that will allow an oralloy sample (93.5% enriched uranium) after a short irradiation in a thermal neutron flux to be transferred from the flux to a counting position in front of a Ge(Li) detector in less than a second. The pulses obtained from the detector are stored in a 1600-channel analyzer. The analyzer's memory was divided into eight subgroups so that each subgroup will represent the gamma spectrum at one of eight particular times after fission. Sixteen spectra were obtained representing times after fission of from 0.5 sec to 2.0 hours. The energy range of these spectra is from 0 to 1130 keV. Over 200 gamma rays were observed, and half lives were determined for most of these. A computer program was constructed that predicts the fission-product gamma spectra at any time after fission according to the response of the Ge(Li) detector. The best values available in the literature were used as data for this program. At the longer times after fission agreement between the experimental results and the predicted spectra is good. Comparison between computed and observed spectra lead to important improvements in the reported values of gamma spectra for short-lived fission fragments. (Diss. Abstr.)

19287 DECAY SCHEMES OF ^{191}Os AND ^{193}Os. Perry, Frank Chester. Pullman, Wash., Washington State Univ., 1966. 68p.

Thesis.

The decay schemes of ^{191}Os and ^{193}Os were studied by means of single gamma and gamma-gamma coincidence spectrometers. Both NaI(Tl) and Ge(Li) detectors were utilized. The decay scheme proposed for ^{191}Os is in agreement with a previously reported scheme. In the decay of ^{193}Os, numerous previously unreported gamma transitions and gamma-gamma coincidences were observed. The decay scheme for ^{193}Os proposed from these data postulates the existence of three previously unreported levels of ^{193}Ir at 660, 713, and 874 keV and appears to resolve certain conflicts among previously reported schemes. From angular correlation measurements and other evidence, spins and parities could be tentatively assigned to many of the levels of ^{193}Ir. In the case of ^{193}Ir there emerges a strong suggestion of the existence of a rotational band based on the ground level ($\frac{3}{2}^+$), of which the first, second, and third excited states are, respectively, the 139-, 362-, and 660-keV levels. (Dissertation Abstr.)

19288 COULOMB EXCITATION OF THE YTTERBIUM ISOTOPES. Palms, John Michael. Albuquerque, N. Mex., Univ. of New Mexico, 1966. 122p.

Thesis.

Coulomb excitation studies were performed on ^{171}Yb, ^{172}Yb, ^{173}Yb, ^{174}Yb, and ^{176}Yb using oxygen ions having energies up to 55 MeV. Resulting de-excitation gamma rays were observed in particle coincidence with a NaI(Tl) detector and as single spectra with a Ge(Li) detector. The ground-state rotational bands of the ^{171}Yb and ^{173}Yb isotopes were excited to the $\frac{13}{2}^-$ level. The $\frac{13}{2}^-$ and $\frac{11}{2}^-$ levels of both nuclei have not been reported before. In addition to the transitions from the ground-state band, gamma rays were observed from ^{171}Yb and ^{173}Yb coming from other bands. A search was conducted for transitions from the decay of vibrational states, but none were observed. These transitions all fit well into a level scheme predicted by the pure rotational model of Bohr and Mottleson. An examination of this same model was also conducted to determine to what extent the electromagnetic properties of the high angular momentum states of the rotational band of the odd-A nuclei are described by the same set of parameters as the lower states. Assuming that the theoretical values for the E2 transition rates are correct, the M1 transition rates, determined from branching ratios, are found to be in excellent agreement with the theory within the experimental error of about 7%. The experimentally determined g_K, the gyromagnetic ratio for intrinsic motion, differs from the theoretical value for both ^{171}Yb and ^{173}Yb. If one assumes that the cause for this is a suppression of the neutron magnetic moment in these nuclei, an effective g_s, the spin gyromagnetic ratio for the neutron, can be calculated to give the experimentally determined value for g_K. The $g_{s,eff}$ obtained for ^{171}Yb and ^{173}Yb is very nearly equal to the value of 0.750. (Dissertation Abstr.)

19289 ANGULAR AND ENERGY DISTRIBUTIONS OF GAMMA RAYS EMITTED FOLLOWING 42-MeV ALPHA-PARTICLE BOMBARDMENT OF SEVERAL RARE-EARTH NUCLEI. Shepherd, Barry John. Seattle, Univ. of Washington, 1966. 221p.

Thesis.

A study of angular momentum populations following compound nuclear reactions induced by 42-MeV alpha particles was carried out by observation of the de-excitation gamma rays. Particular emphasis was placed on the study of rare-earth nuclei, with targets chosen to yield an even residual nucleus. Angular distributions and cross sections were obtained for several transitions in the ground-state rotational bands of ^{156}Dy, ^{158}Dy, ^{162}Er, ^{164}Er, ^{168}Yb, and ^{172}Hf. Also measured were total yields, mean energies, and angular distributions of the gamma rays which precede the rotational cascade. The energy resolution of the detector (a NaI crystal in an anticoincidence annulus–using timing information to suppress background) was adequate to permit one to distinguish the rotational lines from the prerotational quanta. The relative cross sections of the transitions in a rotational band increase as one goes down the band. The observations here were compared with predictions obtained from an extension of the method used to predict spin isomer ratios. To predict angular distribution parameters, calculations of angular momentum substate populations were performed, using a semiclassical model. The model describes the effect of the statistical emission of photons and neutrons on an initial angular momentum population in terms of two parameters, α and β. α is inversely related to the mean square angular momentum carried off during the emission process, and β is inversely related to the square of the usual spin cut-off parameter. The average measured angular distributions of that part of the statistical emission with energies between 1.5 and 2 MeV are not consistent with the assumption that the emission is purely dipole. The distributions fit pure quadrupole emission if we have $\mathcal{I}/\mathcal{I}_{rig}$ between about 0.3 and 1. If we assume that the emission consists of equal parts of dipole and quadrupole multipolarity then $\mathcal{I}/\mathcal{I}_{rig}$ must be between about 0.2 and 1. The measured anisotropies and relative strengths of the rotational transitions are consistent with predictions based on the emission of an average of three quadrupole photons before the rotational cascade, with $\mathcal{I}/\mathcal{I}_{rig}$ between about $\frac{1}{4}$ and 1, and with reasonable assumptions concerning the angular momentum population in the initially formed compound nucleus. If the prerotational cascade emission is assumed to be a mixture of dipole and quadrupole photons then $\mathcal{I}/\mathcal{I}_{rig}$ must be between about 0.2 and 1. The average number of

gamma rays (2.4 ± 0.2) and average energy (2.13 ± 0.08 MeV) was measured for that part of the statistical emission with energies between 1 and 5 MeV following 42-MeV alpha-particle bombardment of rare-earth targets. A cascade calculation was performed by hand, using a simple dependence for the gamma transition probability as a function of energy and assuming the excitation energy U and temperature T are related by $U = (A/8)T^2$. A comparison of the measured spectra with calculations suggests that the prerotational quanta are in part quadrupole and in part dipole. This result is qualitatively in agreement with the implications of the angular distribution measurements for these same quanta. It is also consistent with the measured angular distributions and relative yields of the rotational transitions. It can be seen that the average multipolarity of the prerotational cascade and the average value for $\mathcal{I}/\mathcal{I}_{rig}$ as determined by this experiment have considerable uncertainties. The conclusions could be made more definite by implementing any of the following steps: Use oxygen-free targets, because above about 4 MeV the contributions from oxygen transitions are at least as large as those from the statistical emission. Use a better strength function when calculating the theoretical statistical spectra. Measure accurately the relative cross sections of the rotational band out to and including the 12^+ level, because there the theoretical predictions are quite sensitive to the assumed value of $\mathcal{I}/\mathcal{I}_{rig}$ and the average multipolarity of the prerotational cascade emission. (Dissertation Abstr.)

19290 OPTICAL-MODEL PARAMETERS FROM AVERAGE TOTAL NEUTRON CROSS SECTIONS. Tabony, Robert Henry. Durham, N. C., Duke Univ., 1966. 118p.

Thesis.

Neutron total cross sections of Ru, In, Sb, I, La, Hf, Ta, W, Re, Os, Ir, Hg, Th, and U were measured in the energy region from 30 to 650 keV. A number of different sample thicknesses were used for each element, and the transmission data were analyzed for s-, p-, and d-wave strength functions and shape-elastic scattering phase shifts by area methods, modified to include the effects of Doppler broadening and the Porter-Thomas distribution function for neutron reduced widths. The important results include the verification of the splitting of both the s-wave strength function peak and the shape-elastic phase-shift peak due to the deformation of nuclei in the neighborhood of A = 170. The broad minimum in the p-wave strength function in the region A = 120–190 as well as the rather large d-wave strength function in the region A = 120 to 190 are also observed. The results are interpreted in terms of the optical model. (Diss. Abstr.)

Nuclear Theory

Refer also to abstracts 18780, 18867, 18959, 19005, 19189, 19192, 19212, 19216, 19232, 19277, and 19290.

19291 (AD–637003) SLOWING DOWN OF ATOMIC PARTICLES BY ELASTIC SCATTERING. Report No. 2-12-66-1. Landshoff, R. K. (Lockheed Missiles and Space Co., Palo Alto, Calif. Research Labs.). May 1966. Contract Nonr-3368(00). 14p. CFSTI $3.00 cy, $0.65 mn.

A reevaluation was made of the differential cross section and the transport cross section for particles interacting with a screened Coulomb potential. The results lie roughly between the earlier ones obtained by Firsov and by Lindhard et al. Experimental data by Lasson et al. lead to lower cross sections especially at low energies. This can probably be ascribed to a failure of the model potential which extends to larger interparticle distances than it should. (auth)

19292 (AD–642510) EFFECT OF THE TWO-PARTICLE SPIN-ORBIT NUCLEON–NUCLEON INTERACTION ON THE ^{16}O AND ^{16}N NUCLEI. Interim Technical Report No. 2. Coulter, Byron L. (Alabama Univ., University). Aug. 1966. 82p. (AROD–4819:3). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis.

Possible nucleon-nucleon interaction potentials are considered, and the form is selected which is thought necessary to obtain a reasonably accurate picture of the ^{16}O and ^{16}N nuclei without necessarily complicating the calculations. The assumptions made to approximate the solution of the Schroedinger equation are discussed, and the potential well introduced by these assumptions is chosen. A mathematical treatment of the methods used for constructing the energy matrices is presented. Theoretical predictions are made of the energy-level splittings of ^{16}O and ^{16}N and of the beta-decay and muon-capture rates for the two nuclei. After a comparison of these results with experimental data, the nuclear state vectors giving the best experimental fit are chosen. The appendices contain three derivations too cumbersome to be included in the main text, but necessary for the completeness of the work, and a summary of formulas from Racah algebra which are used throughout the calculations is included. (auth)

19293 (INSJ–102) PROPOSAL OF NEW TYPE OF EXPERIMENT FOR INVESTIGATION OF LOW-LYING EXCITED LEVELS IN ATOMIC NUCLEI. Sakai, Mitsuo (Brookhaven National Lab., Upton, N. Y. Tokyo Univ. (Japan). Inst. for Nuclear Study). Dec. 1, 1966. 5p. Dep. mn.

A proton with an appropriate energy can produce in the compound nucleus an isobaric analog state which can correspond to the parent nucleus of a beta transition. The electromagnetic transitions from this state to the low-lying states can be intimately related to the beta transitions from the corresponding analog parent state to the same excited states. It is proposed that experiments based on this type of process could be used to investigate low-lying excited levels in nuclei. (S.F.L.)

19294 (ISS–66/29) IL SEMINARIO DEI LABORATORI DI FISICA NEL QUADRIMESTRE MAGGIO–AGOSTO 1966. (The Seminar at the Physics Laboratory During the Period May–August 1966). (Istituto Superiore di Sanita, Rome (Italy). Laboratori di Fisica). Sept. 9, 1966. 54p. (In Italian). Dep. mn.

A synopsis of the lectures held at the Physics Laboratory of the Istitute Superiore di Sanità is presented. The lecture topics were the potassium–argon method for the measurement of the geological time, radioactive contamination of the population, recent results from experiments in the Werner Institute, Uppsala, studies on the structure of nucleic acids, studies on the nature of crossing-over in Aspergillus nidulans, modification and selective chemical fracture of the polypeptide chain, algebra of the currents and spectroscopy of baryons, prognoses on bone cancer with the Bayes statistical method, techniques of streamer chamber, quasi-elastic scattering reactions and the interaction in the final state, ferritin-labeled antibody for electron microscopic investigations of antigens, antibodies, and antigen-antibody reactions, fidelity in the translation of the genetic code, and amber suppression and the ribosomes. (J.S.R.)

19295 (PHS–999-RH-21) COMPUTER PROGRAM FOR THE ANALYSIS OF GAMMA-RAY SPECTRA BY THE METHOD OF LEAST SQUARES. Phillips, Charles R.; Stewart, Jon A.; Athey III, T. Whit (Public Health Service, Washington, D. C. Div. of Radiological Health). Aug. 1966. 24p. Public Health Service Free.

A computer program, written in Fortran II and Fortran IV languages for the IBM 1620 and 7040-1401 computers, respectively, is presented for the analysis of gamma spectra by the method of least squares. The Fortran IV main program and four subroutines are included. The method is accurate, agreeing favorably with estimated standard deviations, and is sufficiently sensitive to be useful for routine analysis of gamma spectra of a substantial number of low-activity samples. Data provided by a verification experiment show that the least squares method is more accurate than the simultaneous equations method. (auth)

19296 (UCRL-50001-66-1, pp 1-40) NUCLEAR AND ATOMIC STRUCTURE. (Lawrence Radiation Lab., Univ. of California, Livermore).

Summaries are given of research on: vector mesons in a Coulomb potential; elementary excitations in an interacting Bose gas; theoretical existence of the Σ^-nn hyperfragment; phenomenological Λ-nucleon potentials; a one-boson exchange model for p-p elastic scattering (0 to 400 MeV) in the context of a strip approximation to the corresponding Mandelstam representation; one-boson exchange models and nucleon-nucleon scattering; potential energy of the hydrogen atom; kinematic singularities introduced by partial-wave projection for the scattering of particles with spin and unequal masses; the $^{18}O(p,d)^{17}O$ and $^{18}O(p,t)^{16}O$ reactions at 18.5 MeV; development of a Moxon-Rae-type gamma detector which has an efficiency which is proportional to the total energy of the incident photons; calculation of fast-neutron inelastic scattering cross sections; a two-nucleon DWBA analysis of data from the $^{19}F(d,\alpha)^{17}O$ reaction; reactions (^{3}He, d) and (He-3,t) on isotopes of carbon, nitrogen, and oxygen with 17.8-MeV ^{3}He ions; angular distributions of the $^{19}F(\alpha,t)^{20}Ne$ reaction to the ground state and various excited states using 28.5-MeV α particles; measurement of photoneutron cross sections just above the neutron binding energy for iron and bismuth; comparison of mirror nuclei resulting from photoexcitation of ^{16}O; measurement of $\bar{\nu}$ (the average number of neutrons released per fission) for neutron fission of ^{242m}Am; cross sections for the (γ,n) and (γ,2n) reactions with ^7Li; characteristic x-ray production in single crystals of Al and Cu by proton bombardment at 70 to 100 keV; the $^{25}Mg(p,n)^{25}Al$ and $^{26}Mg(p,n)^{26}Al$ reactions to assess the applicability of a strong coupling deformed isospin model in describing the (p,n) charge-exchange reaction; the two-body force by the $^{14}C(p,n)^{14}N$ reaction; elastic scattering of 7- to 14-MeV neutrons from nitrogen; the x-rays from the fission of ^{235}U with a bent-crystal spectrometer; secondary standard γ-ray energies;

and neutron production cross sections using protons of 7.5- to 14.0-MeV energy. (S.F.L.)

19297 COMPLEX HIGH-ENERGY REACTIONS ON HEAVY ATOMIC NUCLEI. Brandt, R. (CERN, Geneva. Max-Planck-Institut fuer Kernphysik, Heidelberg). Atompraxis, 13: 15-20 (Jan. 1967). (In German).

An introductory survey is given on such concepts as spallation, fission, and the Serber model. Then certain experimental nucleochemical methods are described with which high-energy reactions (E > 1 GeV) can be carried out on heavy nuclei (A > 200), with special consideration of the CERN studies: classic radiochemical studies, improvements made by using an isotope separator, determination of ranges, and mica investigations. The subsequent discussion summarizes the (definitely incomplete) results obtained so far, and points out the further experimental and theoretical studies which will be necessary. (auth)

19298 OPTICAL POTENTIAL IN THE GAS APPROXIMATION. Weigel, M. (Univ., Frankfurt am Main). Z. Phys., 200: 398-409(Mar. 14, 1967).

Using the gas approximation, the optical potential is expressed as a function of the scattering matrix of nucleon-nucleon scattering. The formalism of Green functions is used. The imaginary part of the optical potential in nuclear matter is calculated for high energies using the experimental phase shifts. In addition, a calculation of the imaginary part is made using the S-wave part of the Tabakin potential. (auth)

19299 EXTREME DAMPING OF SINGLE-PARTICLE WAVE FUNCTIONS IN THE NUCLEAR INTERIOR. Schenter, R. E. (Battelle-Northwest, Richland, Wash.). Phys. Rev. Lett., 18: 465-8(Mar. 20, 1967).

Single-particle wave functions which describe the elastic scattering of low-energy neutrons were calculated from nonlocal optical potentials constructed in terms of the fundamental nucleon-nucleon interaction and the ground-state wave function of the target. It was found that these single-particle wave functions are greatly reduced in the nuclear interior in comparison with those generated from equivalent phenomenological local and nonlocal optical potentials. (auth)

19300 CALCULATION OF NUCLEON–PHONON INTERACTION EFFECTS IN A SIMPLE NUCLEAR MODEL. Balbutzev, E. B.; Jolos, R. V.; Mikhailov, I. N. (Joint Inst. for Nuclear Research, Dubna, USSR). Acta Phys. Pol., 31: 371-80(Feb. 1967).

The results of calculation of the energy spectra in a simple model with nucleon–phonon interaction are given. The comparison of the exact values of the energy with the evidence obtained by strong coupling method allows a determination of the range of application of this method. It is shown that the conditions under which the equidistant character of the spectrum is revealed are considerably wider than those under which the collective degree of freedom is extracted. (auth)

19301 GRANULAR MOESSBAUER ABSORBERS. Bowman, J. D.; Kankeleit, E.; Kaufmann, E. N.; Persson, B. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Nucl. Instrum. Methods, 50: 13-21(1967).

The shape of Mössbauer spectra is studied for absorbers consisting of a powder randomly dispersed in a carrier. A general method of calculation is developed and illustrative special cases are discussed which indicate significant deviation from uniform absorber spectra. (auth)

19302 INTERMEDIATE-FIELD RADIO FREQUENCY TRANSITION SCHEME FOR A SOURCE OF POLARIZED PROTONS. Kuhfeld, A. W. (Univ. of Minnesota, Minneapolis). Nucl. Instrum. Methods, 50: 147-9(1967).

A scheme of radio-frequency transitions useful for production of polarized particles by atomic beam methods is described. It can be substituted for the low-field transition of Abragam and Winter in many situations, but does not cause an identical set of population transfers. The total atomic angular momentum F is preserved in the transitions, which interchange the populations of two levels at a time in a magnetic field of such magnitude that these transitions may be considered to be independent. The transition scheme works for any hydrogenic atom; specific operating parameters are given for all three isotopes of hydrogen. (auth)

19303 EFFECTIVE INTERACTIONS IN NUCLEAR STRUCTURE. Goldhammer, Paul; Nachamkin, Jack (Univ. of Kansas, Lawrence). Physics, 3: No. 1, 69-78(Jan. 1967). (COO–1120-44).

The theoretical justification of effective interactions for shell-model calculations is discussed in terms of t-matrix theory. A peculiar difficulty arises when t-matrix elements are fitted to energy levels, in that the single-particle basis functions are unknown. A criterion under which the t-matrix will act like a two-body interaction operator is presented, and the problem of relating the residual interaction to the phenomenological interaction is discussed. (auth)

19304 IS THE NUCLEUS ROUGH OR SMOOTH? Wilkinson, Denys H. (Oxford Univ.). Comments Nucl. Particle Phys., 1: No. 1, 36-9(Jan. 1967).

It is pointed out that only short-range correlations of nucleons in the nucleus that loosen the Fermi sea can lead to the formation of sub-units such as alpha particles that represent a higher order of short- and medium-range correlation. The question is considered whether a heavy nucleus is smooth in the sense that most of the surface matter consists of uncorrelated nucleons, or rough in the sense that a fair fraction of the surface matter is condensed. Evidence that may be provided by experimental studies of alpha decay, knock-out reactions, and K-meson capture is discussed. (L.B.S.)

19305 NUCLEAR STRUCTURE AND REALISTIC FORCES. Brink, David M.; Peierls, Rudolf E. (Oxford Univ.). Comments Nucl. Particle Phys., 1: No. 1, 32-5(Jan. 1967).

A survey is presented of new work in the treatment of finite nuclei using interactions consistent with information derived from the extensive data on the two-nucleon problem. The difficulties encountered in bridging the gap between two-nucleon data and potentials generally used in nuclear calculations are pointed out. Methods developed by Brueckner, Bethe, and Goldstone and modifications to the Brueckner method are reviewed, and examples of nuclear structure calculations are noted. (L.B.S.)

19306 FURTHER REMARKS ON THE EXTENDED SIEGERT THEOREM. Fujita, J. I. (Tokyo Univ.). Phys. Lett., 24B: 123-4(Feb. 6, 1967).

The validity of the so-called Ahrens-Feenberg approximation is reinvestigated, and experimental tests are proposed. (auth)

19307 THE GROUND STATE OF ^{3}H WITH SEPARABLE NONLOCAL INTERACTION WITH HARD SHELL REPULSION. Borysowicz, J.; Dabrowski, J. (Univ. of Warsaw). Phys. Lett., 24B: 125-8(Feb. 6, 1967).

The ^{3}H ground-state problem is solved exactly with a separable nonlocal nucleon–nucleon potential with a hard shell repulsion of radius r_c. The best value of the binding energy, 8.3 MeV, is obtained with a charge dependent potential with $r_c = 0.4$ fm. In this case the S′ state probability $P_{S'} = 2.4\%$. (auth)

19308 WEAK COUPLING MODEL OF PARTICLES AND HOLES IN THE sd SHELL NUCLEI. Arima, A. (Univ. of California, Berkeley); Horiuchi, H.; Sebe, T. Phys. Lett., 24B: 129-31(Feb. 6, 1967).

Excited states in the sd shell are described by weak coupling of particles and holes. (auth)

19309 EFFECT OF VELOCITY DEPENDENCE IN NUCLEON–NUCLEON INTERACTIONS. Kiang, D. (Dalhousie Univ., Halifax, Can.). Phys. Lett., 24B: 132-4(Feb. 6, 1967).

It is pointed out that velocity dependence does not necessarily have a repulsive effect. In fact, a velocity-dependent one-boson-exchange potential model is "softer" than an equivalent, static one-boson-exchange potential model. (auth)

19310 INTERMEDIATE STRUCTURE. Feshbach, Herman (Massachusetts Inst. of Tech., Cambridge). Comments Nucl. Particle Phys., 1: No. 1, 40-5(Jan. 1967).

A remarkable nuclear phenomenon which has recently been uncovered in the course of investigations of nuclear reactions is pointed out — the presence of an intermediate scattering resonance in the differential cross section as a function of energy, which under better resolution is found to break up into many narrow resonances. Examples of various types of intermediate resonances are given, and questions bearing of the nature of these resonances in nuclear and particle physics are discussed. (L.B.S.)

19311 CENTRAL INTERNUCLEAR INTERACTION IN IRREDUCIBLE FORM. IV. SOME GENERAL PROPERTIES OF THE MATRIX OF CENTRAL FORCES. Vanagas, V. V.; Petrauskas, A. K. (Inst. of Physics and Mathematics, Academy of Sciences, Lithuanian SSR). Lietuvos Fiz. Rinkinys, Lietuvos TSR Mokslu Akad., Lietuvos TSR Aukstosios Mokyklos, 6: 335-42(1966). (In Russian).

The coefficients of the exchange interaction entering the expression of the central internuclear forces matrix are discussed. Tables of those coefficients for most symmetrical light nuclei orbital states are presented. Some general properties of submatrices of the orbital interaction are outlined. (auth)

19312 ESTIMATION OF ELASTIC SCATTERING CROSS SECTIONS OF GAMMA RAYS FROM DIFFERENT ELEMENTS. Singh, M.; Anand, S.; Sood, B. S. (Punjabi Univ., Patiala, India). Indian J. Phys., 40: 367-72(July 1966).

A method for the estimation of elastic scattering cross sections of low-energy gamma rays from different elements at different scattering angles is described. The analysis makes use of the exact calculations of Brown and Mayers for mercury and the experimental data on Z dependence. The estimated values show a good agreement with the available experimental data. (auth)

19313 REARRANGEMENT COLLISIONS AND HEAVY PARTICLE STRIPPING. El-Nadi, M.; Rihan, T. H. (Atomic Energy Establishment, Cairo). Ann. Phys. (N. Y.), 41: 287-301(Feb. 2, 1967).

The formal theory of rearrangement collisions is discussed, following the works of Day et al. and Robson, using a different representation. It was found that heavy particle stripping could arise from the process of antisymmetrization, as discussed previously by Robson, just as from the residual interaction. The latter contribution, which was found to be larger in magnitude than the earlier one, takes place when the state of the core of the target nucleus is changed by the reaction. The reaction $C^{13}(p,n)N^{13}$ is considered as an illustration, in which the heavy particle stripping contribution arising from core excitation was calculated. (auth)

19314 INTERMEDIATE STRUCTURE AND DOORWAY STATES IN NUCLEAR REACTIONS. Feshbach, H.; Kerman, A. K.; Lemmer, R. H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Ann. Phys. (N. Y.), 41: 230-86(Feb. 2, 1967). (MIT-2098-267).

Intermediate structure in the energy dependence of cross sections is interpreted in terms of an intermediate model, which describes the transition amplitude averaged over an energy interval which is much larger than the width and spacing of the compound nuclear levels, but which is much smaller than the widths of the structure in the optical model cross sections. The intermediate structure is ascribed to resonances in the intermediate amplitude, which in turn are assumed to be the consequence of the existence of doorway states which are described and defined. A formalism is developed which takes the existence of these states explicitly into account. The resultant amplitude is then averaged and the intermediate model obtained. For an isolated doorway state this amplitude can be divided into a slowly varying part and a rapidly varying resonant part. The energy width of the resonant term equals the width of the doorway state, which is composed of an escape width into open channels, and a decay width into more complex excitations. Strength functions are shown to exhibit intermediate structure. These results are generalized to the case of overlapping doorways. Reactions as well as elastic scattering are discussed. The results are put in a form which permits the analysis of experimental data in terms of intermediate model resonances, and the quantum numbers of the doorway states extracted. Experimental situations which would tend to exhibit intermediate structure, and the identification of such structure as an intermediate model resonance, are outlined. Some examples of intermediate structure are discussed. (auth)

19315 INTERACTION BETWEEN POTENTIAL RESONANCES AND COMPOUND STATES WITH STRONG COUPLING. Prats, F. (George Washington Univ., Washington, D. C.); Bauer, M. Rev. Mex. Fis., 15: 327-38(1966).

Previous work on the strong coupling between potential resonances and compound nucleus states suggested the possibility of the appearance of anomalies in the resulting phase shifts. Such anomalies could result in a modification of the shape of the resonances, or even give rise to additional peaks in the cross-section. This possibility is explored in the framework of the Dirac model of resonance scattering. (auth)

19316 DISTRIBUTION OF ABSOLUTE VALUES OF PROJECTED ANGLES. De Alba, E.; Jaidar, A.; Martinez Negrete, M. A. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis., 15: 311-19(1966). (In Spanish).

Keil, Zeitler, and Zinn [Z. Naturforsch-15a: 1031(1960)] have calculated and tabulated the angular distribution of particle trajectories in collisions with matter when the average number of collisions is between 0 and 20. An extension of these calculations is made to cover the distribution of absolute values of projected angles. (auth)

19317 PROPOSALS FOR EXPERIMENTS ON ELASTIC SCATTERING. Nurzynski, J. (Australian National Univ., Canberra). Austral. J. Sci., 29: 153-8(Dec. 1966).

Current problems in elastic scattering are reviewed. It is pointed out that systematic measurements are needed with particles for which the optical potential is not well known (especially ^{3}He and tritons). Some specific features of the angular distributions of these particles which are insufficiently understood and which could be studied within the framework of a general program of investigation of elastic scattering are discussed. It is suggested that target-spin dependent forces and strong coupling between the odd nucleon and a permanently deformed core could be measured by elastic scattering experiments. It is shown that to obtain a better insight into the mechanism of the interaction leading to elastic scattering it is essential to extend measurements over a wide range of angles and to use isotopically pure targets. (S.F.L.)

19318 ISOTOPE SHIFTS AND INTRINSIC DEFORMATIONS IN Ba. Comaniciu, N.; Draganescu, V.; Ionescu-Pallas, N. J.; Tatu, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 11: 669-76(1966).

The parameters of nuclear deformation, α, and the intrinsic nuclear quadrupoles, Q_0, were determined by using the values of isotopic displacements of Ba II, λ 4934 Å and Ba II, λ 4554 Å lines in enriched samples of ^{134}Ba, ^{135}Ba, ^{136}Ba, ^{137}Ba, and ^{138}Ba isotopes. (auth)

19319 GENERALIZED TREATMENT OF NEUTRON-PROTON PAIRING IN N = Z NUCLEI. Chen, H. T.; Goswami, A. (Case Inst. of Tech., Cleveland. Western Reserve Univ., Cleveland). Phys. Lett., 24B: 257-9(Mar. 20, 1967).

It is shown that under certain assumptions the problem of the simultaneous treatment of J = 0 and T = 0 pairing also can be reduced to the solution of gap equations of the usual form. (auth)

19320 ADDENDUM TO FINITE RANGE EFFECTS IN (d,p) REACTIONS. Goldfarb, L. J. B. (Univ. of Manchester, Eng.). Phys. Lett., 24B: 264-5(Mar. 20, 1967).

Attention is given to the modifications of the predictions of finite-range effects in deuteron stripping reactions due to the D-state of the deuteron. (auth)

19321 NUCLEAR MATTER AND THE LONG-RANGE PART OF THE NUCLEON–NUCLEON POTENTIAL. Pearson, J. (Univ. of Montreal). Can. J. Phys., 45: 1289-95(Mar. 1967).

Elementary nuclear-matter calculations are performed with five different central nucleon-nucleon potentials. The potentials are all static with a hard core of radius 0.4 fm and an OPEP tail, but are characterized by vastly different forms in the intermediate region. It is concluded that nuclear matter is insensitive to the precise form of the central part of the nucleon-nucleon potential everywhere beyond the short-range repulsive region, provided that the nucleon-nucleon data are well fitted. (auth)

19322 NUCLEAR FORCE AND NUCLEAR MATTER. I. Akaishi, Yoshinori (Kyoto Univ.); Takada, Kenjiro; Takagi, Shuji. Progr. Theoret. Phys. (Kyoto), 36: 1135-49(Dec. 1966).

The saturation curves of nuclear matter are calculated using the reference spectrum method (RSM) for five types of nuclear forces: the Gammel–Thaler potential, the Hamada–Johnston potential, two kinds of potentials derived by Tamagaki and Watari which have very small core radii, and a potential having a negative 1-s force. Calculations are performed up to the D wave. The corrections to the RSM are also evaluated. The results show that it is almost impossible to get satisfactory properties of the nuclear matter with the Hamada–Johnston-type potentials (including the modified Hamada–Johnston potentials). (auth)

19323 NUMBER OF PROBLEMS IN THE FIELD THEORY OF MANY BODIES. Vagradov, G. M. Tr. Fiz. Inst., Akad. Nauk SSSR, 36: 3-9(1966). (In Russian).

Field theory is used to describe a system of fermions where the forces between the particles are paired. With the use of field methods it is possible to obtain general relations between various characteristic functions such as between the peak maxima, the effective potential, etc. The stability of the ground state is investigated on the assumption that the interaction potential between the particles contains two parts: a short-range repulsive component and a long-range attractive component. The results of nuclear theory where the empirical interaction potential of free nucleons can be represented as the sum of two such contributions are used as a guide. An equation is obtained for the effective potential V, and the general properties of the V function are examined. The dispersion relation is obtained. Certain general relations are obtained on introducing a meson field. It is shown that in the case of the repulsive interaction, the effective potential V as a function of ω can have regions corresponding to plasma oscillations. In the case of the attractive interaction, the potential V is imaginary with respect to ω so that the system can not be considered to be stable. (TTT)

19324 PARTIAL-WAVE ANALYSIS OF 20-GeV PROTON–NUCLEUS SCATTERING. Frahn, W. E.; Wiechers, G. (Univ. of Cape Town). Ann. Phys. (N. Y.), 41: 442-55(Feb. 17, 1967).

The angular distributions and total cross sections of 20-BeV protons scattered by eight target nuclides ranging from Li to U are analyzed by means of the strong absorption model of Frahn and Venter. The analysis accounts for contributions from both

coherent and incoherent (quasi-elastic) scattering. Good agreement with all the data is obtained for a consistent set of parameters. The main result of this investigation is conclusive evidence for a sizable negative real part of the coherent scattering amplitude. In high-energy approximation this corresponds to a real part of the central proton-nucleus potential which is repulsive in the nuclear surface. (auth)

19325 NUCLEAR REACTIONS. Lemmer, R. H. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Rep. Progr. Phys., 29: 131-70(1966).

From IAEA Conference on Nuclear Data, Paris.

The methods and application of Feshbach's unified reaction theory are presented for nuclear reactions involving the scattering of nucleons by nuclei. The method of projection operators that is used leads to a reformulation of the many-body scattering problem in terms of a generalized optical potential for single-nucleon channels. The resulting transition amplitude for nucleon scattering then breaks up into two components that describe resonance scattering and potential scattering, or direct interaction scattering in the case of inelastic processes. The amplitude for potential scattering arises from the average interaction the nucleon experiences with the target nucleus, plus effects coming from far-off resonances. For scattering from nuclei this component in the transition amplitude is expected to vary slowly with energy as compared with the resonance component. The definition of compound states of the target nucleus plus incident nucleon that can form during a reaction is shown to have a natural definition in the framework used as eigenstates of a many-body Hamiltonian in which the interaction with the open channels has been reduced to zero. No joining radius appears in the formulation. The use of projection operators leads to formulas for the transition amplitudes that are obtained algebraically from the equations of motion describing the scattering. The Breit-Wigner resonance forms of the transition amplitude that apply in the vicinity of a compound resonance are thus obtained without prior specification of the representation used for the scattering channels, i.e., no break-up into partial waves is required, contrary to experience with the standard R-matrix formulation of resonance scattering. The results hold in any representation. This flexibility allows one to derive compact expressions for various nuclear cross sections in an arbitrary representation. The procedure is illustrated by obtaining differential and total cross sections for resonance scattering of nucleons in a jj coupling representation for later use in connection with the nuclear shell model. Recent developments and applications of the formalism to some problems of nuclear structure are discussed. (auth)

19326 THEORY OF THE GIANT DIPOLE RESONANCE. Brenig, W. (Max Planck Institut fuer Physik, Munich. Technische Hochschule, Munich). pp 59-113 of Advances in Theoretical Physics. Vol. I. Brueckner, Keith A. (ed.). New York, Academic Press, 1965.

A brief survey is given of the experimental techniques that have been used in connection with the giant dipole resonance. This is followed by presentations on cross sections, the response function, sum rules and mean energies, the liquid-drop model, the shell model, effective forces and renormalization, numerical results, and the width of the giant resonance. (S.F.L.)

19327 OPTICAL MODEL. Fetter, Alexander L.; Watson, Kenneth M. (Univ. of California, Berkeley). pp 115-94 of Advances in Theoretical Physics. Vol. I. Brueckner, Keith A. (ed.). New York, Academic Press, 1965.

The formal properties of the optical model are introduced using elastic scattering, derivation of the optical-model potential, the adiabatic approximation, application to rearrangement collisions, and binding energy of a many-particle system. This is followed by application of the model to high-energy scattering, generalization of the optical potential, the optical potential at low energy, and the optical potential in the T approximation. (S.F.L.)

19328 HEAVY ION TRANSFER REACTION. Greider, K. R. (Yale Univ., New Haven). pp 245-82 of Advances in Theoretical Physics. Vol. I. Brueckner, Keith A. (ed.). New York, Academic Press, 1965.

Heavy-ion transfer reactions are theoretically investigated in which two nuclei scatter in their mutual Coulomb field while a particle (considered to be a neutron) is exchanged from one nucleus to another. The problem is examined by both the DWBA and T-matrix approaches, the latter involving the extension of the theory to more complicated processes, including proton transfer and several-particle transfer reactions. (S.F.L.)

19329 KNOCKOUT AND j-FORBIDDEN STRIPPING REACTIONS. Strobel, George L. (Univ. of California, Davis). Phys. Rev., 154: 941-50(Feb. 20, 1967).

By definition, j-forbidden stripping reactions have zero cross sections if the filling order of the simple spherical shell model is followed and if only the usual direct stripping mechanism is considered. Several j-forbidden stripping reactions have been observed, and all have similar characteristics. One conceivable explanation of these similarities is a common knockout reaction mechanism whereby the deuteron is captured by the target while knocking a proton out of the target. The calculated differential cross sections for knockout are indeed similar to each other, but differ grossly in shape and magnitude from the observed differential cross sections. It is concluded that the knockout reaction mechanism, by itself, does not explain the observed j-forbidden stripping cross sections except possibly in the reaction $^{10}B(d,p)^{11}B^*$. (auth)

19330 ANALOG RESONANCE MODULATION OF FINE STRUCTURE IN NUCLEAR DOORWAY STATES. Fallieros, Stavros (Bartol Research Foundation, Swarthmore, Pa.); Ferrell, Richard A. Phys. Rev., 154: 921-4(Feb. 20, 1967). (NYO-3525-13).

The doorway-hallway model of fine structure is extended to the case of an additional doorway state, the analog resonance, which is assumed not to have any associated hallway states. The analog resonance acts as a simple probe of the coupled doorway-hallway system and produces a characteristic destructive interference in the fine structure at a particular point in the spectrum, indicating the presence of a nearby doorway state. (auth)

19331 ACCURACY OF THE BETHE-FADDEEV EQUATION. Petschek, A. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 154: 934-5(Feb. 20, 1967). (LA-DC-8188).

The accuracy of the Bethe and Day solutions of the Bethe-Faddeev equations is tested by applying the methods to a soluble problem. While both approximations differ from the exact solutions, the deviations are not so large as to invalidate the conclusion that the three-body terms are likely to be small. (auth)

19332 DISTORTED CLUSTER STATES IN SCATTERING THEORY. Hahn, Yukap (Univ. of Connecticut, Storrs). Phys. Rev., 154: 981-8(Feb. 20, 1967).

Difficulties connected with the asymptotic behavior of adiabatic wave functions in the scattering theory of slow collisions are discussed in the time-independent formalism. It is shown that the Born-Oppenheimer approximation, and its generalization involving a finite number of adiabatic states, can not satisfy the correct asymptotic boundary conditions. A slightly different basis set of distorted cluster states is constructed which avoids this difficulty and yet fully contains the distortion effect. Symmetric treatment of the three-particle scattering system is given in the multidimensional form, and the nonadiabatic corrections and their approximations are discussed. Resonances as complex energy poles of the amplitudes are shown to be contained in the nonadiabatic correction terms and are analyzed in terms of the effective potentials. An application of the method to high-energy fast collisions is briefly discussed. (auth)

19333 COUPLED-CHANNEL CALCULATIONS FOR NUCLEAR BOUND STATES. Rost, E. (Princeton Univ., N. J.). Phys. Rev., 154: 994-1004(Feb. 20, 1967). (PUC-937-226).

The method of coupled channels is presented for situations where all channels are bound. A numerical relaxation technique is formulated for such problems and is found to be rapid and reliable. Calculations are performed for deformed nuclei (where angular momenta in a rotational band are coupled) and for the Lane isospin $t \cdot T$ potential (where proton-nucleus and neutron-analog compositions of a target nucleus are coupled). In either case the relevant radial functions may be used as form factors for the analysis of stripping or pickup experiments. The calculations are applied to deformed components in spherical nuclei (^{18}O and ^{40}Ca); a deformed nucleus (^{25}Mg); j-dependent effects in the $1f_{\frac{7}{2}}$ shell; and the extraction of (p,d) spectroscopic factors in the $1f_{\frac{7}{2}}$ shell using the Lane potential. The effect of the channel coupling is found to be important in many instances. (auth)

19334 EIGENSTATES OF THE J = 0, T = 1, CHARGE-INDEPENDENT PAIRING HAMILTONIAN: II. SENIORITY-ONE AND -TWO STATES. Richardson, R. W. (New York Univ., University Heights). Phys. Rev., 154: 1007-22(Feb. 20, 1967).

Exact equations for the seniority-one states of 2N + 1 nucleons in an arbitrary external potential well and interacting through a J = 0, T = 1, charge-independent pairing force are derived and, for a large class of states, are solved exactly. The states in this class are characterized as having wave functions that are totally symmetric in the isospins of the paired particles. These states have total isospin $T = \frac{1}{2}, \frac{3}{2}\ldots, (2N + 1)/2$. The states with the lowest energy consistent with the given values of N and T are contained in this class of states. All the states of 2N + 1 neutrons or protons belong to the charge multiplet with $T = (2N + 1)/2$. Equations for the seniority-two states of 2N + 2 nucleons are also

derived, and the solutions to these equations that are totally symmetric in the isospins of the paired particles are considered. These solutions may be classified as charge-symmetric or charge-antisymmetric according to their parity under reflection in isospin space. The equations for the charge-symmetric state are solved exactly. These states have total isospin T = 1,3, ... , N + 1 for N even and T = 0,2, ... , N + 1 for N odd with each value of T not equal to zero occurring twice. The equations for the charge-antisymmetric states are solved in an approximation which conserves the isospin of the unpaired particles and which is exact when they occupy degenerate levels. These states have total isospin T = 0,2, ... , N for N even and T = 1,3, ... , N for N odd with each value of T not equal to zero occurring twice. The calculation of all these states is reduced to the diagonalization of a tridiagonal matrix, whose eigenvalue is given explicitly in terms of N and T, and the solution of N coupled, nonlinear, algebraic equations. The wave functions and energies of all the states of these systems having the indicated isospin symmetry and the given value of T are given in terms of the solutions of these equations. An explicit expression for the occupation probabilities of the levels of the single-particle potential (summed over the two charge states) is given. This expression may be evaluated by the solution of an N × N system of linear algebraic equations. (auth)

19335 STATISTICAL DESCRIPTION OF THE COMPLEX-BOUNDARY-VALUE PROBLEM. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 154: 891-3 (Feb. 20, 1967).

The statistical properties of the parameters of the statistical collision matrix defined in terms of the eigenstates of a complex-boundary-value problem is studied starting from the Hamiltonian of the system. It is shown that the random-matrix hypothesis can be used to calculate the statistical distribution of quantities such as the complex amplitude. An explicit calculation is carried out for the special case of two dimensions. As a check on the theoretical calculation, it is shown that the results of the real-boundary-value problem follow by suitably choosing a parameter. (auth)

19336 STATISTICAL DESCRIPTION OF THE COMPLEX-BOUNDARY-VALUE PROBLEM. II. DISTRIBUTION OF THE PARAMETERS OF THE COLLISION MATRIX. Ullah, Nazakat (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 154: 893-7(Feb. 20, 1967).

A detailed statistical study is made of the parameters of the statistical collision matrix using the N-dimensional random complex orthogonal matrix. It is shown that, even without a complete knowledge of weight function which has to be introduced for the convergence of the normalization integral, certain relations between the average values of the parameters of the statistical collision matrix can be obtained and a statement can be made that the channel correlations of the parameters are always positive. A suitable form of the weight function is guessed, and the distributions of the parameters are also given. It is shown that under certain conditions the distribution of the parameters is close to the Porter–Thomas distribution except for small values. The resonance correlations of the parameters are also studied. Excellent agreement was obtained between the values predicted by the present theoretical formulation and those obtained by a numerical calculation using the parameters of the real-boundary-value problem and a certain transformation matrix. (auth)

19337 NUMERICAL CALCULATIONS OF HYPERFINE INTERACTIONS IN PERTURBED ANGULAR CORRELATIONS. Ballesteros, R.; Salomon, M. (Univ., La Plata, Argentina. CNEA, Argentina). Nucl. Instrum. Methods, 44: 171-3(Sept. 1966).

Calculations were made of the perturbation of the angular correlation of two consecutive radiations in a nuclear decay due to coupling of the magnetic moment of the intermediate nuclear level to the magnetic moment of unpaired electrons in the atom or molecule of the decaying nucleus. It is shown how to determine the hyperfine coupling constants from experimental data. (S.F.L.)

19338 LEVEL DENSITY AND THE STRUCTURE OF ATOMIC NUCLEI. Shubin, Yu. N.; Malyshev, A. V.; Stavinskii, V. S. (Inst. of Physics and Energetics, Obninsk, USSR). Vienna, International Atomic Energy Agency, 1966, Preprint No. CN-23/106, 14p. (In Russian). (CONF-661014–38). DTIE.

An analysis is made of experimental data on neutron resonance density on the basis of a nearly independent-particle model taking into account residual interaction (pairing energy). A detailed correlation is established between a basic theoretical parameter (the single-particle level density near the Fermi surface) and the nuclear shell structure. It is observed that this correlation is connected not only with the type of filling of single-particle levels of real nuclei, but also with their grouping in shells as determined by proton and neutron magic numbers. A formula is derived for calculating this parameter for a nucleus with a given number of protons and neutrons. The analytical results give reason to hope that the more extensive experimental information on nuclear level density will make it possible to determine more exactly the character of the spectrum of elementary excitations in a degenerate system of strongly interacting fermions. (auth)

19339 COULOMB EXCITATION. Alder, Kurt; Winther, Aage (eds.). Perspectives in Physics. A Series of Reprint Collections. New York, Academic Press, 1966. 380p. $8.50.

A collection of some important reprints on experimental and theoretical aspects of electromagnetic excitation of nuclei by ion bombardment is presented. A number of these reprints are not readily available. A short introduction is given which surveys the subject field. (W.D.M.)

19340 TEXTBOOK OF NUCLEAR PHYSICS. Smith, C. M. H. New York, Pergamon Press, 1966. 844p. $11.50.

A general coverage of nuclear physics is provided in a self-contained manner which includes an introduction to atomic physics, relativity theory, and quantum mechanics as a basis. Chapters are included on beta decay, the neutron, fission, particle accelerators, electronic techniques, elementary particles, and thermonuclear reactions in stars. (S.F.L.)

19341 DEUTERON STRIPPING ON DEFORMED NUCLEI. Iano, Peter Joseph. Pittsburgh, Univ. of Pittsburgh, 1965. 132p.

Thesis.

Interference of indirect transition amplitudes with the direct transition amplitude for deuteron stripping on deformed nuclei is investigated. The indirect transitions that are considered are those that arise via intermediate rotational excitations of the target and product nuclei. These indirect transitions are introduced by generalizing the initial and final distorted waves so that they include inelastic amplitudes. A straightforward coupled-channels treatment of the generalized distorted waves is described. However, a quantitative investigation of the coupled-channels formulation is not attempted because of the enormous numerical difficulties that such a procedure would present. Instead, the rotational motion of the target is treated adiabatically, thereby, in principle, inelastic amplitudes in all rotational channels are accounted for simultaneously. Further simplification is achieved by treating the coupling of the rotational coordinates to the projectile coordinates to only first order. Calculations are performed for deuteron stripping on ^{24}Mg and ^{238}U. The calculations indicate that the indirect amplitudes are small, transitions via intermediate excitations in the deuteron channel dominate the indirect amplitudes, the indirect amplitudes generally flatten the angular distributions of the reaction protons, and the ratio of the strength of the indirect transitions to the direct transition is fairly independent of the mass of the target. Although the spin-orbit force is neglected, the theory predicts a J-dependence in the angular distributions that is significant at all angles. The predicted J-dependence of the angular distributions is compared with the observed distributions in one instance. The comparison is favorable. Although the indirect stripping amplitudes are small, they produce measurable effects in the differential cross section when they add coherently to the direct amplitude. The most dramatic effects of the indirect amplitudes are changes of the angular distributions of the reaction protons. In addition, the calculated spectroscopic coefficients are changed by a significant amount when the indirect amplitudes are taken into account. (Diss. Abstr.)

REACTOR TECHNOLOGY

Central Power Reactors

Refer also to abstracts 17567, 17755, 17922, 17924, 18318, 19183, 19454, and 19479.

19342 (AECL-2642) HEAT TRANSFER, IMPURITIES, AND FOULING IN ORGANIC COOLANTS. A Summary of Canadian Experience. Hatcher, S. R.; Finlay, B. A.; Smee, J. L. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). May 1966. 31p. Dep. mn. AECL $1.00.

The impurities found in organic coolants are discussed with particular emphasis on fouling and the hydriding of Zr alloys. Cl_2 and O_2 should be avoided in the coolant, but the presence of about 100 ppM water reduces both fouling and hydriding rates. Results from the X-7 in-reactor loop demonstrated that fuel can be irradiated to high burnup with negligible fouling. However the fouling in the larger U-3 loop is somewhat higher, probably due to the higher radiolytic damage rate in the coolant. Radiation, the presence of O_2 and absence of water increased the fouling potential in the U-3 loop. Coolant temperature and rate of purification by clay adsorption had little effect. Methods for control of impurity levels are discussed. Further development is required to assess the relative merits of coolant processing methods necessary to achieve minimum fouling of the fuel. (auth)

19343 (ANL-7212) EXPERIMENTAL BOILING-LIQUID-METAL FAST REACTOR. Armstrong, R. H.; Carter, J. C. (Argonne National Lab., Ill.). June 1966. Contract W-31-109-eng-38. 83p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The existing facilities of the EBR-I installation are proposed for the purpose of investigating the characteristics of fast solid-fuel reactors in which liquid metal is boiling under controlled and observable conditions. An integral unit is designed to fit into the existing EBR-I core cavity and to connect to the existing auxiliary facilities; the technical aspects are discussed, and a test program is presented. (auth)

19344 (ANL-7269) COMPARISON AND ANALYSIS OF THEORETICAL DOPPLER-COEFFICIENT RESULTS FOR FAST REACTORS. Hwang, R. N.; Ott, K. (Argonne National Lab., Ill.). Dec. 1966. Contract W-31-109-eng-38. 18p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Comparison and analysis of the theoretical Doppler coefficient for fast reactors as calculated independently at ANL and KFK were made. The factors that affect the magnitude as well as the temperature behavior of the Doppler coefficient were examined in great detail. The results are indicative of the possible causes of significant discrepancies in the previous comparison of this kind. (auth)

19345 (APDA-181) CYLINDRICAL FUEL ELEMENT FLOW STABILITY PROGRAM. Edwards, J. J.; Brown, C. H. Jr.; Clancy, R. J.; Friedland, A. J. (Atomic Power Development Associates, Inc., Detroit, Mich.). Jan. 31, 1967. Contract AT(11-1)-865. 173p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The isothermal, hydraulic testing program is concerned with the effect of wire pitch and wire diameter on the coolant pressure drop of wrapped-wire supported rod assemblies. Spatial distribution of the velocity head can be used as a basis for structural analysis of wrapped-wire support rod assemblies with geometries similar to Na-cooled fast breeder reactor fuel element configurations. (M.L.S.)

19346 (BNWL-326) POWER REACTOR DESIGNS. AN ANNOTATED BIBLIOGRAPHY. Appleby, E. R. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1966. Contract AT(45-1)-1830. 703p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An annotated bibliography of power and heat reactor design studies, produced by computer printout of information available through December 1966 is presented. Sections of the Bibliography group the designs into broad reactor types, as listed in the Table of Contents. Each design is given an alpha-numeric code. Pagination follows this alpha-numeric order, with the reactor code number appearing at the upper right hand corner of each page. Tabs are provided for locating the sections. (auth)

19347 (BNWL-SA-926) ANALYSIS OF PLUTONIUM FUELED LIGHT WATER REACTORS. Dawson, F. G.; Deonigi, D. E.; Liikala, R. C.; Jenquin, U. P. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 3, 1967. Contract AT(45-1)-1830. 34p. (CONF-670306-2). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From IAEA Symposium on Uses of Plutonium as a Reactor Fuel, Brussels, Belgium.

Analysis of physics problem areas, nuclear characteristics, and economic aspects associated with plutonium utilization in water reactors are presented. In evaluating the analysis methods, the theoretical methods are combined with the basic cross sections and the system is called the physics model. The model is evaluated by comparing calculated and measured values of neutron multiplication, k_{eff}, for light water moderated critical experiments using the best values of the microscopic cross section data. A survey study was made to determine the approximate magnitude of the various reactivity coefficients for Pu-fueled light water reactors. Several possibilities are examined for modifying the fuel lattice design of a uranium oxide fueled reactor so that Pu is burned more efficiently, i.e., Pu value is increased. Studies are reported for an optimum Pu recycle reactor with PuO_2 in natural or slightly enriched UO_2. The power distribution problems that arise when a reactor is partially reloaded with fresh fuel assemblies containing recycle Pu are discussed and the loading schemes are presented. (J.C.W.)

19348 (CEND-265) ADVANCED BONUS CORE DEVELOPMENT PROGRAM. Final Report. Gibbons, J. F.; Anderson, L. E.; Knapp, R. W.; Grubelich, F. T.; Mordarski, W. J. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.). Feb. 28, 1966. Contract AT(40-1)-3154. 278p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary description is presented of design and development of the reactor carried out during the period from Jan. 1963 to Dec. 1965. The information is presented in sections on core design, plans for fuel element irradiation testing, thermal cycle testing, materials and component evaluations, and fabrication methods development. (J.R.D.)

19349 (COO-651-32) ELK RIVER REACTOR SYSTEM MONITORING DATA, AUGUST 1965-JUNE 1966. (Rural Cooperative Power Association, Elk River, Minn.). Sept. 1966. Contract AT(11-1)-651. 61p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A summary of radiochemical activities during the period are summarized. Major activities related to operation of the reactor during the period include repair of evaporator leaks, off-gas system testing, investigation of high radiation levels due to primary system gas buildup, refueling, control rod inspection and repair, and investigation of primary-to-secondary system leaks. Data are included that were obtained by analysis of samples from a regularly scheduled in-plant program. (J.R.D.)

19350 (CVNA-275) MONTHLY OPERATING REPORT, JANUARY 1967. (Carolinas Virginia Nuclear Power Associates, Inc., Parr, S. C.). Contract AT(30-1)-2289. 29p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

At the beginning of the month, the reactor was operated at 90% of the licensed power level with failed fuel in pressure tube J-6, which contains normal fuel. Later in the month the power level was increased to 95%. Reductions in power were made on several occasions, particularly after increases in Primary Coolant System radioactivity were observed, in order to monitor the entire reactor core and locate any additional failed fuel that might be present. As a result of these efforts another fuel failure was located in pressure tube J-7, which also contains normal fuel. On January 24th, a leak developed in the Main Steam Header Relief Valve which led to a shutdown of the reactor for repair of this valve. During this shutdown another fuel failure was located in pressure tube R-3, which contains R&D fuel. Since reactor operation is not permitted with an indicated failure of an R&D fuel assembly, the reactor remained shutdown and at the end of the month refueling preparations were underway. (auth)

19351 (EURAEC-1524) STUDY ON BURNOUT HEAT FLUX IN BOILING WATER. Quarterly Report No. 18, January 1-February 28, 1966. Mayinger, F.; Schad, O.; Weiss, E. (Maschinenfabrik Augsburg-Nuernberg A. G., Nuremberg (West Germany)). Mar. 1966. Contract 057-61-RDD. 32p. (EUR-2817). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Joint Research and Development Program.

A number of measurements were performed which showed that orificing at the inlet of a highly stressed heating channel is a reliable and effective way of preventing pulsating burnout. Since increased orificing requires additional pump power, every effort is being made to keep this pressure drop, which is produced for reasons of pulsation safety, as low as possible. Studies were there-

fore previously carried out on this minimum orificing for different thermodynamic and hydrodynamic design conditions. These measurements were taken on internal-flow round pipes 7 mm in diameter at mass flow rates of 230 to 400 g/cm²/sec and pressures of 70 and 100 atm. The orificing is carried out by reducing the flow section and thus has a double influence on the pulsations. On the one hand, the oscillations are damped as a result of the increased friction, and on the other, there is a partial reflection of the pressure waves at the orificing point. Studies were performed to determine what quantitative effect low mass flow rates of 100 to 250 g/cm²/sec have on minimum orificing and to what extent it is affected by the diameter of the test channel. Further measurements were therefore performed in the pulsating burnout range at the above pressures on round internal-flow pipes 11 and 15 mm in diameter and the reduction in the orificing effect for decreasing mass flow rate and increasing flow section determined. With these geometric and hydrodynamic parameters it is much better to ensure that there are no spaces filled with compressible substances immediately upstream of the heating channel, since they have a far greater influence on pulsating burnout than the orificing. In the hydrodynamically stable burnout range measurements were carried out with a sinusoidal heat flux distribution over the length of a round internal-flow pipe (L/D ratio 80). The maximum heat flux in the middle of this pipe was precisely double the minimum value at the two ends. The measurements showed that the same total heat input is possible with this heat flux distribution as with uniform heat flux, which in comparison with this latter indicates that the heat flux density at the peak of the sinusoidal distribution is greater by a factor of 1.2. (auth)

19352 (EURAEC–1729) CATALOGUE OF BURNOUT CORRELATIONS FOR FORCED CONVECTION IN THE QUALITY REGION. Clerici, G. C.; Garriba, S.; Sala, R.; Tozzi, A. (Applicazioni e Ricerche Scientifiche, Milan (Italy)). Dec. 1966. Contract 073-65-11 TEEI. 130p. (EUR–3300.e). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

The correlations are first listed in their original form using the symbols and units employed by their authors. Conditions for application include heat transfer channel geometry and type of heat flux distribution. The correlations are also written in a standard form showing the relations of burnout heat flux with burnout steam quality at the outlet. A comparison of the correlations for uniform heat flux distribution in round ducts is included. (J.R.D.)

19353 (EURAEC–1774) USE OF PLUTONIUM AS A FUEL IN NUCLEAR REACTORS. Quarterly Report No. 11, July 1–September 30, 1966. (Centre d'Etude de l'Energie Nucleaire, Brussels (Belgium). Societe Belge pour l'Industrie Nucleaire, Brussels). Nov. 1966. Contract 001-64-1 TRUB. 75p. (EUR–3322; BN–6611-07). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Fusion tests on UO_2 compressed into pellets in brass crucibles showed that there was no UO_2-brass reaction, and that the efficiency was of the same order of size as that obtained with the quartz crucible. A system of positioning the powder column by means of hollow crimped pellets with Poral discs was developed and used in fabricating forty rods for neutron tests. It appears that the vibration sequence is not the dominant factor in heterogeneous Pu distribution inside the rods. Results of investigations show that the oxygen content of mixed oxides can be determined by coulometry after dissolution in a mixture of $AlCl_3$–KCl. Contact gammagraphy inspection of 6 and 7 diameter rods with one generator is representative of the longitudinal activity distribution. Post-irradiation examination of the rods irradiated at about 800W/cm in the third series of irradiation tests in the hydraulic conveyor did not reveal any variations in size. Initial metallographic examination showed the appearance of grain sintering Visual examination of the rods irradiated in the first boiling water capsule up to 10,000 MWd/t did not reveal any deformation, corrosion, or anomalies at right angles to the welds. Dimensional measurements did not show any deformation of the canning. Initial examinations on the BR-3/PWR rods did not reveal any variations in size. Theoretical work was chiefly concerned with calibrating and adapting the Cadilhac code used for calculating neutron spectra in the thermal region, and with interpreting the results of the pulsed sub-critical measurements effected on the Thetis fuel. Work was continued on adapting the VENUS critical facility. The starting date for the critical tests depends primarily on the time the grids are delivered and on solving the safety problems. An initial evaluation of the incidence of plutonium recycling in a PWR plant was started, using arbitrary data; it shows the need for relatively elaborate optimization. (auth)

19354 (GA–6667) GAS-COOLED FAST BREEDER REACTOR. Annual Progress Report for the Period Ending July 31, 1965. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Oct. 1, 1965. Contract AT(04-3)-167. 164p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work performed on a research and development program initiated to establish the practicality of a gas-cooled fast breeder reactor system is summarized. Design studies are presented on the use of helium or CO_2 coolants with carbide or oxide fuels and their effects on the performance of the system. Major emphasis of the work is in the area of fuel element development for the reference design concept using helium coolant and mixed Pu–U oxide fuel. Experimental programs are discussed for fuel-cladding-coolant interaction studies, fuel pin testing in the Experimental Beryllium Oxide Reactor, Flex-can fuel element development, and fuel element materials development. (H.D.R.)

19355 (GA–7378) LATTICE PHYSICS STUDIES. Quarterly Progress Report No. 1 for the Period Ending July 31, 1966. Neill, J. M. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Aug. 26, 1966. Contract AT(04-3)-167. 21p. (EURAEC–1719). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

Improved techniques for the design of water-cooled and water-moderated nuclear reactors are to be achieved through the study of lattice spectra, both cell-averaged and spatially dependent. The studies are to be made by the time-of-flight method in assemblies consisting initially of single or simple-multiple rod cell configurations. The data are to be compared to integral measurements such as spectral indices, disadvantage factors, and reactivity. The measurements are to be interpreted using the best known transport and diffusion theory codes available. Investigation of the most satisfactory scattering kernel for H_2O and cross section set for the fuel nuclides are also to be made. Experimental techniques are to be developed to allow measurements in more tightly packed lattices. Subsequent to the satisfactory development of the experimental techniques, spectral measurements are to be performed in lattices of specific interest to the Euratom program. This will include rods of varying enrichment of ^{235}U or ^{239}Pu at various spacings. Temperature and poison may be other allowable variables. The data are to be compiled, interpreted and correlated, and then distributed to other workers in the field. At the beginning of the research program, there are essentially two problem areas that require disposition. The first problem is the extraction from existing data on water lattices of the outstanding uncertainties in the calculations for these lattices. The second problem is the investigation of the limitations imposed by the time-of-flight apparatus, and the determination of what modifications are necessary to carry out the research program as efficiently as possible. (auth)

19356 (GEAP–5144) DEVELOPMENT PROGRAM ON THE GARIGLIANO NUCLEAR REACTOR. Quarterly Report No. 14. Howard, C. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1, 1966. Contract AT(04-3)-189. 19p. (EURAEC–1635). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States–Euratom Joint Research and Development Program.

During the report period three movable ion chamber assemblies were inserted in the reactor after removal of the flux wire guide tubes. Preparations for the reactor stability and plant system tests are essentially completed; the tests are to be conducted after plant startup. (auth)

19357 (GEAP–5301) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 10, August–October 1966. Horst, K. M. (comp.) (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Nov. 1966. Contract AT(04-3)-540. 108p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Bases for use in planning the SEFOR experimental program are summarized. Information and discussion are included concerning techniques for obtaining transfer functions from the oscillating output signals, the effects of delayed photoneutrons from Be, and analysis of fuel loading procedures. Progress is reported on fuel development, special instrumentation, and investigations of steady-state and transient characteristics of the core assembly. Development effort directed toward reactivity controls required for experimentation is reported. Progress is reported on development of fuel handling equipment. Design progress on the SEFOR core is summarized. (J.R.D.)

19358 (GEAP–5404) EVESR NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. Eighteenth Quarterly Report, September–November 1966. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation). Dec. 1966. Contract AT(04-3)-189. 34p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The EVESR plant availability for the period was 94%, including a planned outage for modifications and refueling which brought the time operating efficiency down to 56%. EVESR operated at power for 53 of the 61 days available, thereby achieving a load factor of about 80%. Cumulative exposures on the EVESR superheat fuel Mark II and III were tabulated. One of the principal objectives of the EVESR Nuclear Superheat Fuel Development Program has been to determine, through tests to failure in EVESR, the actual design and performance limits of steam-cooled fuel. However, the EVESR fuel, though of experimental and deliberately marginal design, has enjoyed unusually good performance during nearly 3 years of operation. Fuel failures have been infrequent and have been traced mostly to excessive temperature conditions. Since the maximum amount of information on the design and application of steam-cooled fuel is obtained when failures occur, accelerated fuel testing conditions have been planned for the final EVESR operating period. The reactor power was cycled between 12.5 and 9.5 MW(t) every 8 hours to induce cyclic plastic strain in the fuel cladding. The cladding temperature in a selected fuel bundle, KB-39, was adjusted to produce a predicted cladding failure after 20 to 50 strain cycles. After 26 such cycles were completed in addition to the prior history of cycling, there was no sign of a cladding rupture. Significant radioactivity release from EVESR fuel was detected only from the deliberately defected Mark III fuel rod in bundle KB-41-2. No other fuel failures were detected. The fission product release from KB-41-2 continues to be moderate, not reaching the magnitude experienced from the service failures in KB-40 and 41. KB-41-2 fission product release data are summarized. To determine the fission product release rate and superheat fuel performance under failed cladding conditions at higher specific power and UO_2 temperatures, a deliberately defected fuel rod has been fabricated with 23.5% ^{235}U enrichment. This fuel rod which is scheduled to be installed in bundle KB-41 will operate at a calculated specific power of 50 kW/kg of UO_2 with central temperature of 4400°F. In the post-irradiation examination of the fuel rods, EVESR fuel bundle KB-29 was disassembled in the fuel storage pool by cutting off the steam riser-downcomer assembly. KB-29 contains nine Mark II annular fuel rods clad with commercial grade Type-304 stainless steel. This fuel exhibited steadily increasing fission product release until its removal from the reactor. After removal of the riser-downcomer assembly, it was found that three of the nine fuel rods were stuck in their process tubes and could not be pulled out. The bundle containing the three stuck rods was transferred to the Radioactive Materials Laboratory where the process tubes will be cut open and the fuel rods examined. Considerable effort was expended during the report quarter to plan and prepare for the shipment of the EVESR fuel to the recovery facility. Following termination of EVESR operation at the end of January 1967, the fuel will be shipped to Savannah River Fuel Recovery Plant. Arrangements have been made to obtain and license shipping casks, to modify fuel and cask handling equipment, and to submit detailed fuel data to Savannah River. Schedules and procedures for fuel disassembly, loading, and shipping have been prepared. (auth)

19359 (GEAP-5405) HIGH POWER DENSITY DEVELOPMENT PROJECT. Quarterly Progress Reports No. 25 and No. 26, June 1966–November 1966. Howard, C. L.; Duncan, R. N. (comps.) (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec. 1966. Contract AT(04-3)-361. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Twenty-three developmental fuel assemblies accumulated exposure as part of an 84-bundle core in the Big Rock Point reactor until a scheduled shutdown on September 17, 1966. During the reactor shutdown, several of the developmental assemblies were visually inspected. Selected fuel rods were removed from some assemblies to obtain dimensional profiles at a later date. Visual inspections revealed gross fuel rod Incoloy cladding failure of peripheral fuel rods in developmental assemblies D-10, D-11, D-12, and D-13. Assembly D-10 contained eight severely failed peripheral fuel rods, and was the most severely damaged bundle. Assembly D-13 contained one visible failed fuel rod. All of these assemblies contained swage-compacted, arc-fused, powder UO_2 fuel. The fuel rods were clad with 0.011-inch-wall, collapsed, cold-worked, weld-drawn, Incoloy-800. The longitudinal fractures in two pieces of Incoloy-800 cladding examined were in both parent metal and weld metal. All fractures were intergranular. The only cracks observed which had partial cladding penetration were in the weld zone itself. These cracks were also intergranular, and started from the outside of the cladding. Very little necking or grain distortion was observed, indicating that both weld and parent metal failures occurred without significant deformation. Only minor general corrosion and crud deposits were observed, indicating normal cladding temperatures. The lack of carbide precipitation also suggests low-temperature operation. The observed fractures appear to be similar to Type-304 stainless steel failures which are associated with environmental factors such as stress-assisted localized corrosion. Fission product activity release measurements on irradiated developmental assemblies D-18, D-19, and D-20 indicated that all three of these assemblies contained leaking fuel rods. These assemblies, containing Zircaloy-2-clad, vibratory-compacted UO_2 powder fuel at exposures of 7280 to 7430 MWd/tU average were not reinserted for continued irradiation pending identification of the leaking fuel rods and the cause. Examination of these assemblies revealed no visible fuel rod failures. Visual inspection of other developmental assemblies (PO-1, PO-3, D-2, and D-4) containing fuel rods clad with Type 304-stainless steel, Zircaloy-2, and Incoloy-800, and fabricated by various processes, revealed no failed fuel rods. Nonuniform crud deposition was observed on all peripheral fuel rods. Variations in the appearance of the crud deposits were observed both along the length of the fuel rods and around the circumference. To date, approximately 200 fuel rods have been removed and reinserted in the various developmental fuel assemblies, verifying the feasibility of the removable fuel rod assembly design. The Big Rock Point reactor was brought to power on May 10, 1966, and operated at nominally full power, 75 MW(e), for the remainder of the month of May 1966. The fission product activity levels, as recorded by the reactor off-gas monitors, increased rapidly, indicating that fuel rod failures were occurring despite the removal of high burnup assemblies containing stainless-steel-clad fuel rods during the April 1966 outage. The reactor power was reduced in steps starting in early June 1966, and was 40 MW(e) just prior to shutdown on September 17, 1966. The appearance of the Incoloy-800-clad, swaged-compacted powder UO_2 fuel rod failures would indicate that a large portion of the off-gas release since April 1966 was from these four assemblies (D-10, D-11, D-12, and D-13). During the outage visual inspections were performed on selected irradiated developmental fuel assemblies using underwater closed-circuit television equipment and a periscope in the Consumers spent fuel pool. The exposures attained prior to the shutdown by the various assemblies which were inspected are summarized. (J.R.D.)

19360 (IFA-FR-49) RESONANCE ABSORPTION OF NEUTRONS, THERMAL UTILIZATION FACTOR, FAST FISSION FACTOR. Bibliography. Rosescu, Teodor (comp.) (Academia R. P. R., Bucharest. Institutul de Fizica Atomica). 1965. 93p. Dep. mn.

The bibliography contains 710 references with authors and titles covering the period 1942 through Aug. 1965. (J.R.D.)

19361 (KAPL-P-3186) THE APPLICATION OF SYNTHESIS TECHNIQUES TO THE CALCULATIONS OF THREE-DIMENSIONAL REACTIVITY COEFFICIENT DISTRIBUTIONS. Bear, J. L.; Judge, F. D.; Venerus, E. R. (Knolls Atomic Power Lab., Schenectady, N. Y.). [nd]. Contract W-31-109-eng-52. 8p. (CONF-661001-44). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From 14th Conference on Remote Systems and Technology, Pittsburgh, Pa.

Flux, power distribution, and associated reactivity level of an array of three-dimensional reactors can be obtained by the multichannel synthesis techniques using perturbation theory. A multigroup theory formulation for reactivity change due to a change in material expressed in terms of perturbation theory is given. Solution of this expression with assumptions involved follows. Results of empirical comparisons are presented. (M.L.S.)

19362 (KR-113) INTRACELL NEUTRON DENSITY DISTRIBUTIONS IN H_2O, D_2O AND H_2O/D_2O MODERATED LATTICES. Stamm'ler, R. J. J. (Institutt for Atomenergi, Kjeller (Norway)). Oct. 1966. 31p. (CONF-660624-2). Dep. mn.

From EAES Symposium on Advances in Reactor Theory, Karlsruhe, Ger.

Intracell neutron density distributions and disadvantage factors were calculated using the computer program, K-7 THERMOS. The influence of the transport correction and the use of different energy transfer models on the density distribution as well as on the spectrum's spatial variation expressed in terms of a suitably defined spectrum index is investigated. Two approximate methods for finding flux disadvantage factors are described and compared with K-7 THERMOS. The results are also compared with those of detailed measurements in metal and oxide fueled cores and in most of the cases satisfactory agreement is observed. (auth)

19363 (LA-3605) ULTRA-HIGH TEMPERATURE REACTOR EXPERIMENT (UHTREX) TRANSIENTS. Vigil, John C. (Los Alamos Scientific Lab., N. Mex.). Sept. 1, 1966. Contract W-7405-eng-36. 25p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Three types of transients in the UHTREX reactor have been numerically evaluated. They are (1) withdrawal of one plug rod starting from near zero power, (2) withdrawal of one plug rod

starting from 3 MW delayed critical, and (3) scrams from 3 MW delayed critical. None of these transients would result in serious damage to the reactor, although in case 2 fuel particle melting occurs if a power scram does not terminate the excursion. Also, stressing of the fuel elements may be significant in case 1. (auth)

19364 (LA-3665) QUARTERLY STATUS REPORT ON ADVANCED REACTOR TECHNOLOGY (ART) FOR PERIOD ENDING JANUARY 31, 1967. PART I. (Los Alamos Scientific Lab., N. Mex.). Feb. 1967. Contract W-7405-eng-36. 11p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Development and testing of instruments and components for Los Alamos Turret Reactor are reported. Calculations for reactor startup are included along with results of transient experiments and fuel testing. (J.R.D.)

19365 (LA-DC-8511) CALCULATION OF INTERACTION PARAMETERS FOR LOOSELY COUPLED REACTOR SYSTEMS. Seale, R. L.; Hansen, G. E. (Los Alamos Scientific Lab., N. Mex.). [1965]. Contract W-7405-eng-36. 15p. (CONF-670107-6). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Nuclear Society, Coupled Reactor Kinetics Conference, College Station, Tex.

Transport theory is used to calculate important parameters for coupled reactor systems. The steady state transport equation is used to determine effective neutron production rate; response of a reactor as a detector is determined. Equations for a cluster of weakly coupled reactors are solved. The results of a one-dimensional Sn solution of the transport theory, in terms of leakage fluxes and leakage flux adjoints, are used to numerically calculate the coupling coefficient in terms of reactivity. An example of evaluation of effective ray time between cores of the Rover (Kiwi)-type reactors is given, as is a lag time calculation. (M.L.S.)

19366 (NAA-SR-12049) A STUDY OF THE EXPANSION OF MERCURY VAPOR. Ostermier, B. J.; Keen, R. D.; Heiskala, V. H. (Atomics International, Canoga Park, Calif.). Mar. 15, 1967. Contract AT(04-3)-701. 94p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A computer program for determining the onset of condensation in a nozzle expansion is described. Experimental evidence for the achievement of high mercury supersaturations is cited, and the components and operation of the experimental mercury nozzle flow system are described. Results of the computer study are discussed and indicate that with dry mercury vapor, no condensation would occur in the experimental nozzle. The experimental data — wall temperatures and static pressures — are presented in plotted and tabulated form for expansions from nozzle inlet pressures between 12.2 and 56.8 psia. Pressure data indicate condensation occurred for expansions for pressures above 30 psia. For all runs, the maximum supersaturations achieved without condensation were calculated using isentropic flow relations and are presented in tabulated form. Wall temperature data did not behave as predicted. An explanation is suggested involving evaporation of entrained droplets in the boundary layer but is not entirely consistent with the data. The effects of an undetected free-stream temperature change on the achieved supersaturations were estimated and are presented in tabulated form. Possible reasons for the occurrences of condensation when not predicted by the theory are suggested as entrained drops in the flow or the failure of the theory to account for the effect of small nuclear size on the surface tension. Suggestions for additional effort are made. (auth)

19367 (NP-16146(Suppl.4)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 4. Kinsman, George (Florida Power and Light Co.). Sept. 6, 1966. 33p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Revised answers to questions submitted by the Director of Reactor Licensing concerning safety aspects of Units 3 and 4 are included. Original answers to the three questions appear in Supplement 2. (H.D.R.)

19368 (NP-16146(Suppl.5)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 5. Kinsman, George (Florida Power and Light Co.). 1966. 157p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Answers to seventeen questions submitted by the Director of Reactor Licensing concerning safety aspects of Units 3 and 4 are included. A revised answer to one question originally included in Supplement 2 and results of an investigation into the characteristics of waves which could reach the plant are presented. (H.D.R.)

19369 (NP-16146(Suppl.7)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 7. Snapp, Roy B. (Florida Power and Light Co.). Sept. 30, 1966. 13p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Additional information on a question submitted by the Director of Reactor Licensing concerning the safety aspects of Units 3 and 4 is included. Previous information on this question appears in Supplements 2, 4, and 5. Supplement 6 to the preliminary safety analysis consists of report WCAP-2987 which contains general background information on core physics. (H.D.R.)

19370 (NP-16146(Suppl.8)) TURKEY POINT NUCLEAR GENERATING UNITS NO. 3 AND NO. 4. Preliminary Safety Analysis Report. Supplement No. 8. Kinsman, George (Florida Power and Light Co.). Nov. 4, 1966. 165p. (DOCKET-50-250; DOCKET-50-251). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Answers to 27 questions submitted by the Director of Reactor Licensing concerning the safety aspects of Units 3 and 4 are included. Additional information on two questions submitted in Supplements 2 and 5 is also presented. (H.D.R.)

19371 (NP-16251(App. G and H)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, APPENDICES G AND H. (Tennessee Valley Authority, Knoxville). [1964]. 112p. (DOCKET-50-259; DOCKET-50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Appendix G presents a core thermal design criteria of the Dresden II class and the similarities and differences of the Browns Ferry design are shown. Differences are discussed and justified with references given which show the changes in basic data that allow the changes in the Dresden II class design. Margins between normal operation and fuel damage levels are shown to be more than adequate. In Appendix H the Browns Ferry design is compared with the "General Design Criteria for Nuclear Power Plants," as published by the Atomic Energy Commission. It is concluded that the Browns Ferry design satisfies all criteria set forth. (M.L.S.)

19372 (NP-16251(Amend.2)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, AMENDMENT 2. (Tennessee Valley Authority, Knoxville). Nov. 2, 1966. 219p. (DOCKET-50-259; DOCKET-50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Revisions to the previously issued Browns Ferry Nuclear Power Station Design and Analysis Reports are given. (M.L.S.)

19373 (NP-16251(Amend.4)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, AMENDMENT 4. (Tennessee Valley Authority, Knoxville). Nov. 18, 1966. 12p. (DOCKET-50-259; DOCKET-50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Detailed answers to questions from the Director of Reactor Licensing, AEC, concerning the Browns Ferry Reactor are given. Topics discussed are: minimum critical heat flux ratios, calculational methods and analytical models used to determine power distribution, critical heat flux along fuel length of limiting channel, mass flow rate, and both steady state and transient performance evaluations for the confirmation of bases for critical design areas including effects of proposed operations. (M.L.S.)

19374 (NP-16251(Amend.6)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, AMENDMENT 6. (Tennessee Valley Authority, Knoxville). [1966]. 184p. (DOCKET-50-259; DOCKET-50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Detailed information on questions from the AEC, Division of Reactor Licensing is given. Material contained in a general category covers the following topics: control rod positioning instrumentation and procedures, refueling procedures, fuel element orientation, fuel rod damage limit, cladding stresses, fuel assembly flow blockage, critical heat flux data, mixing within fuel assembly, and blowdown model. Information concerning accident analysis covers the following: transients, steam line break, rod drop, refueling excursions, water logging, uranium dioxide enthalpy range, and control rods. Material on the core cooling systems covers the following: description of cooling systems, diesel generator sizing, break region where HPCI turbine rotors alone satisfies cooling requirements, containment flooding applicability of core spray tests, emergency system sizing, service water system, protection of control room from turbine missiles, pressure and temperature associated with 27.5% metal-water reaction, shared-control-rod-drive hydraulic systems pumps, relative elevations of different pumps with respect to containment torus, plutonium inventory and design on basic accident, control room shielding, d.c. power systems, and leak detection. (M.L.S.)

19375 (NP-16251(Amend.7)) BROWNS FERRY NUCLEAR POWER STATION DESIGN AND ANALYSIS REPORT, AMEND-

MENT 7. (Tennessee Valley Authority, Knoxville). [1967]. 35p. (DOCKET–50-259; DOCKET–50-260). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Detailed answers to questions posed to the TVA by the Advisory Committee on Reactor Safeguards are given on the following subjects: core cooling margins for fuel ratings, containment capability, limits on number of fuel element failures, fuel element failure modes in loss-of-coolant conditions, isolation valve leakage during large steam line break, fuel temperature rise during depressurization from HPCI to LPCI, blowdown calculations, consequences of flow restrictions to fuel assemblies, fuel failure due to flow blockage, effect of fuel failure on pressure rise within assemblies, protection against corrosion in the torus, instrumentation to initiate the LPCI system, and prevention and consequences of fatigue cracks in reactor vessel. (M.L.S.)

19376 (NP–16580(Vol.1)) NUCLEAR PLANT, DIABLO CANYON SITE. VOLUME I. PRELIMINARY SAFETY ANALYSIS REPORT. (Pacific Gas and Electric Co., San Francisco, Calif.). [nd]. 425p. (DOCKET–50-275(Vol.1)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Volume 1 of the preliminary safety analysis report for the Diablo Canyon Power Reactor includes the following sections: description, site and environment, reactor, reactor coolant system, containment system, engineered safeguards, and plant instrumentation and control. (M.L.S.)

19377 (NP–16580(Vol.2)) NUCLEAR PLANT, DIABLO CANYON SITE. VOLUME II. PRELIMINARY SAFETY ANALYSIS REPORT. (Pacific Gas and Electric Co., San Francisco, Calif.). [nd]. 382p. (DOCKET–50-275(Vol.2)). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Volume two of the preliminary safety analysis report for the Diablo Canyon Power Reactor includes the following material: electrical systems, auxiliary and emergency systems, steam and power conversion system, radioactive waste and radiation protection, safety evaluation, and operation. (M.L.S.)

19378 (ORNL–3955(Vol.1)) HISTORY OF THE AEC SODIUM COMPONENTS DEVELOPMENT PROGRAM. Savage, H. W. (ed.) (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 401p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The Na components development program is an effort to demonstrate competence for the design and fabrication of safe, reliable, and economical components for advanced sodium-cooled nuclear power plants. The development of the supporting technological reports includes the effects of Na on containment materials, measurement of impurities in Na, the Na equipment, heat exchangers for steam generation, and operating experience. Committee meeting reports are recorded. (J.C.W.)

19379 (ORNL–3955(Vol.2)) HISTORY OF THE AEC SODIUM COMPONENTS DEVELOPMENT PROGRAM. Savage, H. W. (ed.) (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 568p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Committee meeting reports on shell-side heat transfer, once-through steam generator, mechanical properties of materials, carbon analysis, Na mass transfer program, sodium components test installation design review, steam generator testing, and analytical procedures for determining impurities in sodium are included. Correspondence between the AEC and the contractors is catalogued. (J.C.W.)

19380 (ORNL–3955(Vol.3)) HISTORY OF THE AEC SODIUM COMPONENTS DEVELOPMENT PROGRAM. Savage, H. W. (ed.) (Oak Ridge National Lab., Tenn.). Dec. 1966. Contract W-7405-eng-26. 484p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Requests and replies from members are given for information on the development of the sodium components program. Coordination reports of the monthly meetings are reported. (J.C.W.)

19381 (ORNL–4036) GAS-COOLED REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING SEPTEMBER 30, 1966. Savolainen, Ann W. (comp. and ed.) (Oak Ridge National Lab., Tenn.). Feb. 1967. Contract W-7405-eng-26. 304p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The development and evaluation of fuel for the High Temperature Gas-Cooled Reactor and for application in the Gas-Cooled Fast Reactor are described as a major effort directed toward the requirements for a 1000 MWe, HTGR reactor design. Fueled-graphite development, investigations of fueled-graphite systems, thermal analysis of AVR-type spherical fuel elements, investigations of moderator materials, considerations for advanced systems, fast reactor development, HTGR nuclear safety considerations, prestressed concrete reactor pressure vessel development, and irradiation testing for EGCR prototype fuels are discussed. (J.C.W.)

19382 (ORNL–TM–908(Vol.1)) MSRE DESIGN AND OPERATIONS REPORT. PART VIII. OPERATING PROCEDURES. Guymon, R. H. (Oak Ridge National Lab., Tenn.). Dec. 1965. Contract W-7405-eng-26. 478p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Information for use in personnel training and for use as a reactor operation reference is presented. A discussion of basic nuclear facts is included along with an explanation of MSRE behavior. Details of operation of each auxiliary system are also included, and minute details of preparing the auxiliary systems for startup are given. (J.R.D.)

19383 (ORNL–TM–1707) FILTRATION OF PARTICULATE AEROSOLS UNDER REACTOR ACCIDENT CONDITIONS. Adams, R. E.; Gill, J. S.; Yuille, W. D.; Parsly, L. F.; Guthrie, C. E. (Oak Ridge National Lab., Tenn.). Dec. 5, 1966. Contract W-7405-eng-26. 35p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The effect of accident environments on the performance of filter systems is being studied on both a laboratory and a pilot-plant scale. In the laboratory the work has included the development of a simple method for generating a simulant aerosol, tests of these aerosols to determine their validity as simulants, and measurements, under various atmospheres, of the efficiency of high-efficiency filter media for removing these simulant aerosols. Moisture has been noted to have a significant effect on the behavior of the simulant aerosol. A limited number of tests have been conducted at the Nuclear Safety Pilot Plant to demonstrate the operation of a larger-scale filter system in a simulated accident environment. (auth)

19384 (ORNL–TM–1773) CAPITAL COST BREAKDOWN FOR COMPARATIVE EVALUATION OF ADVANCED CONVERTERS. Olson, R. C.; Hoskins, R. E. (Oak Ridge National Lab., Tenn.). Feb. 22, 1967. Contract W-7405-eng-26. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Tables of costs for various types of reactors are presented according to major accounts. These tables allow for comparison of relative investment costs. (M.L.S.)

19385 (RISO–128) DYNAMIC ASPECTS OF BOILING-HEAVY-WATER NUCLEAR REACTORS. PART I. Kjaer-Pedersen, Niels (Danish Atomic Energy Commission, Risoe, Research Establishment). Aug. 1966. 55p. Dep. mn.

A general recapitulation of the elements of boiling-water-reactor dynamics is presented. A qualitative survey of the most important physical effects to be considered is included along with a review of the proper mathematical tools for a quantitative description. A linearized transfer-function model of a boiling-heavy-water reactor cooling channel is established. A realistic example is worked through by means of a digital computer and concluded in a set of transfer-function plots. (auth)

19386 (RT-FI–(66)21) UN METODO DI CALCOLO PER PROBLEMI DI CINETICA DEI REATTORI TERMICI. (A Method for the Calculation of Kinetic Problems of Thermal Reactors). Norelli, F.; Pepino, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 17p. (In Italian). Dep. mn.

Non-spatial reactor kinetics problems were solved by a Lanczos' perturbation of the linear operators, which is operated by minimum-norm, such as Legendre or Chebichev, polynomials. Aspects of the method were pointed out and the results, for simple mathematical and physical problems, are listed; a comparison is made between the "Fourier-like" method used and the classical "Taylor-like" step-by-step procedure. (auth)

19387 (TID–23729) CIVILIAN NUCLEAR POWER. The 1967 Supplement to the 1962 Report to the President. (Atomic Energy Commission, Washington, D. C.). Feb. 1967. 59p. Dep. GPO $0.40.

A view of the program and prospects as they appear at the start of 1967 is discussed. Information is included for updating the factors affecting energy sources, requirements, and economics of potential growth in the nuclear power economy. A review of the development program as of the start of 1967 is presented, and information for use in updating legal and administrative aspects is included. (J.R.D.)

19388 (UJV–1632) ELEKTRONICKA APARATURA PRO RIZENI REAKTORU. (Electronic Equipment for the Control of a Reactor). Blaho, D. (Ceskoslovenska Akademie Ved, Rez, Ustav Jaderneho Vyzkumu). Dec. 1966. 10p. (In Czech). Dep. mn.

Electronic equipment is described for automatic control of reactors with moving detecting elements. The equipment processes the pulses from the neutron detector and supplies output signals for reactor and control of the positions of the detection elements The electronic equipment consists of a linear pulse amplifier, a pulse discriminator, a linear and a logarithmic counting-rate meter, a comparison circuit, and protecting circuits. (auth)

19389 (WAPD–311) COMPONENT EXAMINATION PROGRAM ON PWR CORE 1 CONTROL ROD DRIVE MECHANISMS. Secrist,

P. W.; Fiorelli, A. J. (eds.) (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 102p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of examination, inspection, and testing of the control rod drive mechanisms used in the PWR Core 1 reactor plant are reported. Radiation surveys, analysis of crud samples, visual examination, dimensional inspection, electrical and performance testing, and metallurgical examination are included. (auth)

19390 (WAPD-TM-640) PM-2A REACTOR VESSEL TEST: DESCRIPTION OF TESTING AND FAILURE CONDITIONS. Monahan, J. M.; Walker, T. J. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jan. 1967. Contract AT(11-1)-Gen-14. 81p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The second or pressure testing phase of the PM-2A Pressure Vessel Test has been completed. A prescribed pressure-temperature sequencing procedure with intentionally installed defects in the cylindrical portion of the vessel wall resulted in brittle fracture at a lower bound condition. The brittle fracture initiated at the defect at −20°F and 4475 psig internal vessel pressure. This report summarizes the design of the test loop, the development and use of specialized equipment, and the results of the series of pressurization tests. The results of a half-scale model test are included with emphasis on their relation to the full-scale pressurization test. The prediction of failure conditions for a pressure vessel including stress, defect size, and temperature on the basis of fracture mechanics was demonstrated for the unirradiated half-scale test. (auth)

19391 (WCAP-2921) PWR CONTROL MANAGEMENT. Barry, Robert Francis (Westinghouse Electric Corp., Pittsburg, Pa. Atomic Power Div.). Apr. 1966. 123p.

Thesis. Submitted to Univ. of Pittsburgh, Pa.

Stabilization of spatial Xe oscillations is an important task for the control management system of large, slightly enriched, Zircaloy clad, pressurized water reactors (PWR's). This aspect of control management is examined in detail with emphasis on the analysis of Xe transients and the methods of analysis. Axial transients and azimuthal transients are analyzed. It is found that part length control rods will dampen out axial Xe oscillations if the part length rods are moved once every few hours to balance the power in the top half and the bottom half of the core. Without the part length rod movement, Xe oscillations would diverge in the core analyzed in this study. The same strategy for moving part length rods is found to stabilize reactors following a scheduled day-night power cycle or a random load variation sequence. Azimuthal oscillations are also examined, and a comparable strategy is found to stabilize this mode of oscillation. In this case, selected full length rods are fully inserted, or withdrawn, to compensate for the spatial imbalance in Xe poisoning. (auth)

19392 (EURFNR-171F) RESULTS OF THE IRRADIATION OF MIXED UO_2-PuO_2 OXIDE FUEL ELEMENTS. Mikailoff, Hubert; Mustelier, Jean-Pierre; Bloch, Jacqueline; Ezran, Leon; Hayet, Lucien (Commissariat a l'Energie Atomique, Paris (France)). Translated from report CEA-R-3066. 87p. (EUR-3084.f). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Work Performed under United States-Euratom Fast Reactor Exchange Program.

In order to study the behavior of fuel elements used for the first charge of the reactor Rapsodie, a first batch of eleven needles was irradiated in the reactor EL 3 and then examined. These needles were made up of a stack of sintered mixed-oxide pellets: UO_2−10% PuO_2. The density was 85 to 97% of the theoretical value. The diametral gap between the oxide and the stainless steel can was between 0.06 and 0.27 mm. The specific powers varied from 1230 to 2700 W/cm^3 and the can temperature was between 450 and 630°C. The maximum burn-up attained was 22,000 MWd/te. Examination of the needles revealed certain macroscopic changes, and the evolution of the fuel was shown by micrographic studies. These observations were used, together with flux measurements results, to calculate the temperature distribution inside the fuel. The volume of the fission gas produced was measured in some of the samples; the results were interpreted taking into account the temperature distribution in the oxide and the burn-up attained. A study was made both of the behavior of a fuel element whose central part was molten during irradiation, and of the effect of Na which had penetrated into some of the samples following can rupture. (auth)

19393 (ORNL-tr-1541) REFERENCE STUDY FOR THE 1000 MWe STEAM-COOLED FAST BREEDER REACTOR (D 1). Mueller, A.; Eggers, B.; Haefele, W.; (and others) (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report KFK-392. 291p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $18.50 fs, $8.93 mf.

A reference study for a 1000-MW(e) steam-cooled fast breeder reactor is presented. The selection of the most important parameters, a brief description of the installation, data tables, description of the reactor facility, reactor physics considerations and calculations, selection of materials and strength calculations, thermodynamics and cooling design, normal operating cycle, safety considerations, and economic factors are discussed. (J.C.W.)

19394 SODIUM TECHNOLOGY AND EQUIPMENT OF BN-350 REACTOR. Leipunskii, A. I.; Pinkhasik, M. S.; Bagdasarov, Yu. E.; (and others). At. Energ. (USSR), 22: 13-19(Jan. 1967). (In Russian).

Information on the construction in the USSR of dual purpose atomic installations with BN-350 reactors was reported at the Third International Conference On The Peaceful Uses Of Atomic Energy at Geneva in 1964 and at the Detroit conference in 1965. The basic technological equipment and the experimental work carried out during this construction are discussed. (tr-auth)

19395 ROLE OF CONDENSATE CLEAN-UP AT ONE-LOOP NUCLEAR POWER STATION. Margulova, T. Kh. At. Energ. (USSR), 22: 19-23(Jan. 1967). (In Russian).

It was shown that in the primary feed water in one-loop nuclear power stations corrosion products appear. As a result of the high solubility of these corrosion products in the saturated vapor the efficiency of their removal with blow-off water is comparatively small and requires the purification of the complete discharge of the condensate on ion exchange filters. Such condensate purification guarantees a continuous deactiviation of the condensate-feed path and removes water-hardening salts from the loops which occur in the condensate as a result of the cooling of the water in combination with the corrosion of the condensator tubes. These protective functions of the condensate purification during possible accidental situations play an important role. Under conditions of condensate purification the filtration velocity can be assumed to be comparatively large which requires filters of small dimension. (tr-auth)

19396 FAST BOILING REACTORS WITH MELTED SALT FUELS. Taube, M. At. Energ. (USSR), 22: 10-13(Jan. 1967). (In Russian).

Fast reactors are classified. The variations of fast reactors with liquid fuels in boiling heat carriers-solvents are examined separately. The advantages of such reactors and the possibilities of their construction are evaluated. The basic characteristics of the reactors are reported. (tr-auth)

19397 USE OF PONTRYAGIN MAXIMUM PRINCIPLE IN PROBLEMS OF MINIMUM CRITICAL SIZES AND MAXIMUM REACTOR POWER. Zaritskaya, T. S.; Rudik, A. P. At. Energ. (USSR), 22: 6-10(Jan. 1967). (In Russian).

The Pontryagin maximum principle is used for the solution of the problem of finding the minimum critical size for a given reactor power and of finding the maximum reactor power for a given critical size. The Pontryagin maximum principle is used also in the determination of the optimum transient interval for reactors and for finding the optimum spacial grouping for reactors having given physical characteristics. This principle is used in two problems encountered in the theory of projected reactors. (tr-auth)

19398 A BRITON'S VIEW OF NUCLEAR POWER IN THE UNITED STATES. Wood, K. (Bechtel Corp., San Francisco). Nucl. Eng., 12: 106-8(Feb. 1967).

Factors affecting the efficiency of the industry, including costs, competition, and project management and organisation are discussed. The reactor licensing procedure is described. (INIS-UK)

19399 HEAT-PIPE THERMIONIC REACTOR CONCEPT. Pedersen, E. S. (Atomic Energy Commission, Risoe, Denmark). Nucl. Eng., 12: 112-14(Feb. 1967).

In the design described thermal power generated in the reactor core is transported by heat-pipes to thermionic convertors outside the core but within a radiation shield. The thermionic emitters are in direct contact with the outside envelope of the heat-pipes and waste heat is removed from the collectors by a liquid-metal cooling system. The heat-pipe consists of a closed tube containing a small quantity of working fluid which evaporates in the reactor core, condenses on the inner surface of the emitter, and is returned to the core by capillary action. (INIS-UK)

19400 MEETING WORLD NUCLEAR FUEL REQUIREMENTS. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Nucl. Eng., 12: 98-100(Feb. 1967).

The world nuclear power development plans require assured supplies of enriched uranium, and the U.S. is able to supply this requirement under agreements for cooperation with other governments or international organisations. Enriched uranium is to be

made available to customers by toll enrichment or, in certain circumstances, by sale. The toll enrichment service, to operate from 1969, is described in detail, and mention is also made of facilities available for reprocessing irradiated fuel. The relation between safeguards incorporated in the U.S. agreements for co-operation and those of the I.A.E.A. is discussed. (INIS–UK).

19401 PROVISION OF NUCLEAR FUEL SERVICES IN EUROPE. Allday, C. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng., 12: 194-5(Mar. 1967).

Prospects for the nuclear fuel industry are examined and it is suggested that integration or at least co-operation will be essential. Assuming that 40,000 MW(e) will be installed by 1975 and 90,000 MW(e) by 1980, estimates are made of the required throughput for UF_6 production from ore concentrate, isotope separation, fuel manufacture, and fuel reprocessing for thermal and fast reactors. Figures are given for the proportional costs of the fuel cycle stages. (UK)

19402 HINKLEY POINT B NUCLEAR POWER STATION. Engineer, 223: 220-1(Feb. 10, 1967).

This station, the second to be built for the CEGB based on the AGR concept, will have 2 reactors producing 623 MW(e) net each at 41.4% efficiency. The cylindrical concrete pressure vessel is designed to withstand CO_2 pressures resulting from a gas circulator outlet pressure of 600 psi. The UO_2/stainless steel fuel bundles, contained in 360 channels, are designed to operate at a mean rating of 11.2 MW/te to an irradiation of 20,000 MW/te. (INIS–UK)

19403 EXPLORATIONS IN ATOMIC ENERGY. Vick, F. A. (Queen's Univ., Belfast). Contemp. Phys., 8: 41-62(Jan. 1967).

The history of the development of the nuclear reactor, and the construction and economic possibilities of nuclear power stations, are outlined briefly. The problem of radiation damage to the steel cladding of fuel elements is traced from its first observation to its final solution. Explorations of the interactions of neutrons of various energies with nuclei of various kinds are described, and the paper concludes with some examples of the uses of radioisotopes. (auth)

19404 MHD IN A NUCLEAR GAS-TURBINE CYCLE. Engineering, 203: 209-11(Feb. 10, 1967).

A base-load power plant design is described comprising a closed-cycle MHD generator coupled to a HTGR reactor. The generator employs alkali-metal seeded inert gas as the working fluid, and utilizes magnetically induced, non-equilibrium ionization. (INIS–UK)

19405 DOUGLAS POINT: CANADA'S NUCLEAR CHALLENGE. Engineering, 203: 255-9(Feb. 17, 1967).

Douglas Point, a full scale prototype for the 1000 MW(e) Pickering station, is described. The single 200 MW(e) heavy water moderated and cooled reactor is horizontally charged with Zircaloy-2 19-rod fuel bundles containing natural UO_2 fuel pellets. Future projects are reviewed. (INIS–UK)

19406 DESCRIPTION AND OPERATION OF THE ARDENNES POWER PLANT. Erkes, P.; Grau, P. Energ. Nucl. (Paris), 8: 520-34(Dec. 1966). (In French).

The Ardennes nuclear power plant contains a PWR reactor with a net electrical power of 266 MW. The essential pecularities of its construction reside in the fact that the nuclear installations are underground and the classical installations are above ground. This reactor went critical in October 1966. The subterranean and classical parts of the nuclear power plant are described in detail. The variation of the constituent parts of the Ardennes reactor from the first generation PWR reactors are reviewed with the emphasis on the chemical control, control rods, fuel assembly, lattice arrangement, energy production in the core, energy extraction from the core, energy transfer from the primary to the secondary systems, charge cycles for the core, and transfer of the irradiated fuel. The financing and production cost are also briefly considered. (J.S.R.)

19407 HALLAM: DEATH OF A CONCEPT. Strauss, S. D. Nucleonics, 24: No. 10, 63-6(Oct. 1966).

With the shutdown in 1966 of the Hallam Nuclear Power Facility, the Na graphite program ended in the U. S. Hallam had been an outgrowth of the Sodium Reactor Experiment of high temperature reactors cooled by liquid metal as heat sources for central power plants. Numerous technical problems developed and were overcome. They do not belie the evidence accruing from the eminently successful operation of a large liquid metal system. (J.C.W.)

19408 ECONOMIC INDEXES OF NUCLEAR POWER PLANTS. Mojovic, Ljubomir (Energoprojekta, Belgrade). Nukl. Energ., 3: 1-8(1966). (In Slovak).

An analysis of the economic conditions in individual countries related to development of nuclear power is presented. The development status of reactor types such as gas-cooled graphite moderated natural U reactors in Britain and France, BWR and PWR enriched U plants in the US and other countries, and heavy water natural U reactors in Canada and India are reviewed. Financial conditions are the basis for global economic indexes of thermal and nuclear power plants. (J.R.D.)

19409 ESTIMATE OF THE PROPOSED NUCLEAR POWER PLANT SITES IN YUGOSLAVIA. Carlbom, Lars (Aktiebolaget Atomenergi, Stockholm); Obradovic, Janko; Mojovic, Ljubomir. Nukl. Energ., 3: 10-12(1966). (In Slovak).

Sites for nuclear power stations in Yugoslavia are analyzed. The comparative economic analysis has comprised the following indexes: the electric power transmission costs from the nuclear power station, namely the alternative conventional power source; costs involved in the construction of transport connections and in the transport of equipment; the costs of the purchase of land, investments into the reactor building with regard to the degree of seismicity and the type of soil; the effect of the temperature of coolant water on the efficiency of the thermodynamic cycle; losses involved in the pumping of coolant water and the costs of radioactive waste disposal. It is difficult to foresee the total costs incurred by the placement of a nuclear power station in an area of high seismicity. It is necessary to analyze the site and the antiseismic design of the reactor and the other vital equipment. On the other hand, it is difficult to define objectively the cost of increased danger. The analyses make possible the choice of a site with substantially clearer insight into its consequences. (auth)

19410 AN ANALYSIS OF POWER-FLATTENING IN A MULTI-REGION REACTOR. I. CONTINUOUS MODEL. Amano, Fumio; Sunako, Katsuhiko. Denki Shikensho Iho, 30: 839-48(Oct. 1966). (In Japanese).

Analysis of thermal neutron fluxes flattened by a continuous absorber in a multiregion reactor is accomplished by use of two-group diffusion theory. A numerical example shows the absorber distribution relationship to size of reactor and its reactivity. (M.L.S.)

19411 THE TREND TOWARD THE USE OF NUCLEAR ENERGY IN THE FEDERAL REPUBLIC OF GERMANY. CONTRIBUTION OF INDUSTRY AND ELECTRICAL TECHNOLOGY. Mandel, Heinrich (Rheinisch-Westfaelisches Elektrizitaetswerk AG, Essen, Ger.). Bull. Schweiz. Elektrotech. Ver., 57: 866-70(Sept. 9, 1966). (In German).

Development of nuclear energy as a means of power production in Germany is discussed. Economics of this development are given from a long-range perspective. Projection of the planned nuclear energy development program in Switzerland is based on this discussion. The Swiss program is outlined and discussed. (TSS)

19412 FORESEEABLE EVOLUTION OF THE ECONOMIC INTEGRATION OF NUCLEAR, CONVENTIONAL THERMAL AND HYDROELECTRIC PLANTS. Angelini, A. M. Energ. Nucl. (Milan), 14: No. 2, 57-70(Feb. 1967). (In Italian).

A general survey of the present state and future possibilities of conventional thermal and hydroelectric power plants is given. Analysis of future power and energy requirements of Italy is performed, and it is predicted that nuclear plants will become economically competitive and, consequently, carry an increasing load. Advantages of advanced converters as nuclear power production facilities are discussed. (M.L.S.)

19413 CRITICAL COMPARISON BETWEEN THEORETICAL AND EXPERIMENTAL TRANSIENTS OF THE ENRICO FERMI PWR. Leoni, G. (CESNEF, Milan); Santarossa, G. Energ. Nucl. (Milan), 14: No. 2, 71-80(Feb. 1967).

A comparison is made between results obtained during a program of dynamic experiments carried out on the Enrico Fermi nuclear power plant at Trino Vercellese and those obtained from mathematical models. It is shown that a reasonably good agreement can be obtained between theoretical and experimental results. An evaluation is made regarding the validity of the main simplifying assumptions on which the models are based. (auth)

19414 MOLTEN SALT REACTOR SHOWS MOST PROMISE TO CONSERVE NUCLEAR FUELS. PART I. MacPherson, H. G. (Oak Ridge National Lab., Tenn.). Power Eng., 71: 28-31(Jan. 1967).

Developments in nuclear power reactors fueled with molten salts are reviewed. Four aspects of use of nuclear reactors of the molten-salt breeder-reactor type are discussed and estimated fuel costs are given. A proposed design of a reactor core cell is shown. Cost estimates for this type of reactor plant are made. (TSS)

19415 MOLTEN SALT REACTOR SHOWS MOST PROMISE TO CONSERVE NUCLEAR FUELS. PART II. MacPherson, H. G. (Oak Ridge National Lab., Tenn.). Power Eng., 71: 56-8 (Feb. 1967).

A liquid fuel handling process for molten-salt reactors is described. The process includes removing fission products and extracting and adding uranium fuel. A proposed salt conditioning system for a 1000-MW plant is outlined and the present status of its development is described. Present status of the technology of molten salts is discussed. (TSS)

19416 REMOVAL OF XENON POISONING FROM A THERMAL NEUTRON REACTOR BY A PULSE METHOD. Trofimov, A. P.; Gorbunov, V. P.; Yurova, L. N. pp 115-32 of Inzhenerno-Fizicheskie Voprosy Yadernykh Reaktorov. Yurova, L. N. (ed.). Moscow, Atomizdat, 1966. (In Russian).

Radioactive ^{135}I decays to ^{135}Xe which is reactor poison because of its high capture cross-section for thermal neutrons. An allowable xenon concentration (^{135}Xe allowable) is defined by the reactivity excess of the reactor. The allowable xenon concentration can be controlled by starting up the reactor at various time intervals. The burn-up of ^{135}Xe as a function of operating time is given for neutron fluxes of 5×10^{13} to 1×10^{15}. The burn-up of ^{135}Xe is followed for start-ups at equal time intervals and for start-ups when the xenon concentration reached the allowable level. The number of reactor start-ups N is analyzed as a function of the duration of a single start-up for various degrees of xenon burn-up. It is possible to increase the effective operating time of a reactor with the use of this procedure. (TTT)

19417 NUCLEAR POWER PLANTS AND EXPERIMENTAL POWER REACTORS IN THE GERMAN FEDERAL REPUBLIC. Rembser, Josef (Ministere Federal de la Recherche Scientifique, Godesberg, Ger.). Bull. Inform. Ass. Belge Develop. Pac. Energ. At., 11: No. 64, 23-7(Nov. 1966). (In French).

An outline is given of the nuclear power plants and experimental power reactors in operation or under construction in the German Federal Republic. These include the Kahl experimental nuclear power plant, multiple-purpose research reactor, Gundremmingen demonstration reactor, Lingen demonstration reactor, Obrigheim demonstration reactor, the AVR reactor, the Grosswelzheim hot vapor reactor, the compact sodium-cooled reactor, and the pressure tube water-moderated CO_2-cooled reactor at Niederaichbach. Some of the individual characteristics of these reactors are given. (J.S.R.)

19418 LONG-TERM CHANGE OF ISOTOPES IN A FAST REACTOR: MATHEMATICAL MODEL AND ITS ANALOG SOLUTION. Frankowski, Waclaw (Inst. of Nuclear Research, Polish Academy of Sciences, Swierk). Nukleonika, 11: 735-44(1966).

Results of a study devoted to the formulation of a mathematical model of the long-term change of Pu isotopes in fast reactors is presented that covers the whole range of possibilities existing in this class of reactors with respect to the core neutron balance. Factors controlling circulation of material between the core and the blanket are analyzed and an analog solution of the change model is included. (auth)

19419 BOILING WATER REACTORS IN THE GERMAN FEDERAL REPUBLIC. Traube, Klaus; Engel, Helmut. Bull. Inform. Ass. Belge Develop. Pac. Energ. At., 11: No. 64, 29-36 (Nov. 1966). (In French).

Four boiling water reactors are under construction in the German Federal Republic. The principal characteristics of these reactors are tabulated and a review is given of the experiences acquired in their conception and construction. (J.S.R.)

19420 REALITY AND PROSPECTS OF NUCLEAR ENERGY. Salvetti, Carlo. Comit. Naz. Energ. Nucl., Notiz., 13: No. 1, 29-39(Jan. 1967). (In Italian).

Discussions concerning the development of nuclear energy, the importance of environmental factors, of the availability of fuel materials, the present world nuclear market conditions, the main lines of nuclear programs in the various countries, the tested reactors, the advanced breeders, and the fast reactors are presented. C.N.E.N.'s technological programs Cirene, Eurex, P.C.U.T., and programs on Pu, fast reactors, nuclear propulsion, and in that of the major technological fuel-cycle operations are discussed. (auth)

19421 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Jerkins, Ernest Edward (to United Kingdom Atomic Energy Authority). British Patent 1,062,824. Mar. 22, 1967. Filed Sept. 4, 1964.

A design is presented for an integral reactor which has the heat exchanger positioned around the core. A coolant chamber with two portions is specified: one portion at the end of the core collects coolant which has flowed over the fuel elements and the other extends to an annular portion, the far end of which serves as coolant inlet. (M.L.S.)

19422 HETEROGENEOUS ATOMIC REACTORS. (to Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete). British Patent 1,055,754. Jan. 18, 1967. Priority date May 28, 1964, Hungary.

A design is given for heterogeneous reactors which are superior to conventional cylindrical reactors from both reactor physics and construction engineering standpoints. The design includes an inner coolant chamber, an outer spherical wall which defines the active zone of the reactor, an inlet pipe for introducing coolant into the inner coolant chamber, and an inner spherical wall, in addition to standard piping for such assemblies. (M.L.S.)

19423 IMPROVEMENTS TO NUCLEAR REACTOR FUEL ELEMENTS. Gauthron, Maurice (to Commissariat a l'Energie Atomique). British Patent 1,055,008. Jan. 11, 1967. Priority date Aug. 28, 1964, France.

A design for cluster-type fuel elements is presented. Better utilization of fuel is allowed by use of connecting materials for the clusters which have good mechanical properties and low neutron absorption. (M.L.S.)

19424 IMPROVEMENTS IN REACTORS. (to Gesellschaft fuer Kernforschung mbH). British Patent 1,054,933. Jan. 11, 1967. Priority date Sept. 15, 1962, Germany.

A design is presented for a reactor core which allows nearly uniform temperature of fuel elements utilizing steam as coolant, and having low consumption of coolant pumping power. The core, either spherically or cylindrically shaped, is adapted for fuel element assemblies which cause the coolant to flow radially toward the core. After the coolant has become superheated in the fuel channels, part of it is sent through a power generation plant while the other is used to evaporate the condensate. (M.L.S.)

19425 IMPROVEMENTS IN AND RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Whiteman, Peter; Douglas, William Alan (to International Research and Development Co. Ltd.). British Patent 1,055,076. Jan. 11, 1967. Filed July 29, 1964.

A design for a canned solid-fuel-type fuel element with good heat transfer characteristics between fuel and can is presented. The fuel is separated from the can by a thermally conducting powder; the powder is compacted from forces outside the can. (M.L.S.)

19426 ZBORNIK MATERIJALA X JUGOSLOVENSKE KONFERENCIJE O ELEKTRONICI, TELEKOMUNIKACIJAMA, AUTOMATIZACIJI I NUKLEARNOJ TEHNICI, ODRZANE 11–13 NOVEMBER 1965 U BEOGRADU. (Proceedings of the Xth Conference of Electronics, Telecommunications, Automation and Nuclear Engineering, November 11–13, 1965, in Belgrade). Belgrade, Godine, 1966. 332p. (CONF-651148).

Separate abstracts were prepared for four papers selected from a total of 25 papers included in Part III (p 197 to 255) of the conference. Other papers in this part are concerned with measurement of absorption integrals, time-dependent transport equation for thermal neutrons, vibration measurements in the RA reactor beamhole, automated power plant fuel change equipment, neutron generator calibration, models for reactor core phase-conversion analysis, and geometry parameters of gas-cooled graphite reactors. Papers in other parts of the conference proceedings are concerned with those areas noted in the title in addition to Nuclear Engineering. (J.R.D.)

For abstracts of individual papers see: 19427, 19428, 19489, and 19490.

19427 HYDRODYNAMIC AND THERMIC CALCULATIONS OF THE BHWR. Spasojevic, D.; Vehauc, A.; Afgan, N. (Boris Kidric Inst., Vinca, Yugoslavia). pp 224-7 of Zbornik Materijala x Jugoslovenske Konferencije o Elektronici, Telekomunikacijama, Automatizaciji i Nuklearnoj Tehnici. Belgrade, Godine, 1966. (In Serbo-Croatian).

A heterogeneous, boiling heavy-water moderated and cooled reactor with natural circulation was examined. Design parameters such as the radial and axial neutron flux distribution, hydrodynamic channel characteristics, water and steam temperature ranges, and thermal conditions within the reactor core were more closely examined. The thermal conditions in the cooling channels were calculated from data obtained on the basis of the radial heat distribution and the geometry of the channels. In the channel calculation it was assumed that identical conditions prevailed in each separate portion. (TTT)

19428 THREE-ZONE METHOD FOR THERMAL AND HYDRODYNAMIC CALCULATIONS OF A BHWR. Studovic, M.; Jovanovic, L.; Jovanovic, S. M. (Boris Kidric Inst., Vinca, Yugoslavia). pp 228-31 of Zbornik Materijala x Jugoslovenske Konferencije o Elektronici, Telekomunikacijama, Automatizaciji i Nuklearnoj Tehnici. Belgrade, Godine, 1966. (In Serbo-Croation).

A new method was developed, dividing the reactor core into three zones and basing thermal and hydrodynamic calculations on the zonal average. Natural circulation is maintained throughout the system: the heavy water passes through the moderator and is heated, being mixed with the recirculating water at the outlet. The geometries for the channels were calculated for a number of core sizes. The calculations are related specifically for heavy-water systems but they are valid also for light-water reactors. (TTT)

19429 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,057,996. Feb. 8, 1967. Priority date Aug. 27, 1964, Luxemburg.

A design is presented for a reactor with thermal shield which is applicable, in particular, to boiling-type reactors. The thermal shield serves not only the purpose of protecting the pressure vessel against radiation, but also as a boiler for the evaporation of the primary fluid. Methods of additional heating of the thermal shield to produce evaporation of the primary fluid are also outlined. (M.L.S.)

19430 A NONLINEAR ANALYSIS OF REACTORS WITH ARBITRARY LINEAR FEEDBACK. Noble, Larry Dean. Ann Arbor, Mich., Univ. of Michigan, 1965. 124p.

Thesis.

The asymptotic behavior of solutions to the nuclear reactor kinetic equation with an arbitrary linear feedback are investigated. Conclusions are included and illustrated by considering specific models for which exact solutions are available and by obtaining numerical solutions for more realistic feedback models. It is seen that in certain cases the transition from the regime of stable oscillations to the dangerous finite escape time case is very abrupt in terms of variations in the initial power. Limit cycle solutions obtained by the method of averaging are found to be in excellent agreement with the numerical results. (J.R.D.)

19431 INVESTIGATIONS ON THE DYNAMIC BEHAVIOR OF COUPLED-CORE NUCLEAR REACTORS. Gage, Stephen John. Lafayette, Ind., Purdue Univ., 1966. 242p.

Thesis.

A unified approach to the problems of spatial and spectral coupling in reactor kinetics is presented which appears to be particularly suitable for the investigation of spectral coupling effects of special interest in large power reactors. For the case of pure spatial coupling, the proposed approach appears to give new insights into the problems of coupled-core and reflected-core kinetics. (J.R.D.)

19432 GENIE ATOMIQUE. TOME TROIS. (Nuclear Engineering. Volume III). Saclay, France, Institut National des Sciences et Techniques Nucleaires, 1965. Paris, Presses Universitaires de France, 1965. 992p.

A series of monographs on nuclear reactors, with emphasis on those constructed in France, is presented. The principles, the experiments made, and the applications are given for each reactor. Low flux reactors and critical assemblies are described. General considerations are presented on the research reactors with high neutron flux. The reactors described in detail are the E1-3, Melusine, Triton, Pegase, Siloe, and Ulysse. Graphite reactors with gaseous coolants—both with natural and enriched uranium—are discussed. The construction techniques for solid moderators are described. The thermal problems connected with the cooling of gaseous reactors are examined. Heavy-water, light-water, and organic reactors are described. Problems of fast neutron reactors are considered. The use of liquid metals for the cooling of reactors is discussed along with the present design tendencies in the area of power reactors. Descriptions of reactors for naval propulsion are included. (J.S.R.)

19433 NUCLEAR REACTOR. Ackroyd, Ronald Tunstall (to United Kingdom Atomic Energy Authority). U. S. Patent 3,285,822. Nov. 15, 1966. Filed Mar. 30, 1964.

A modified gas-cooled, graphite-moderated reactor is described in which reactivity control is effected by shifting the spectrum of neutron energies in the reactor core. The system to provide for this variable moderation in the core comprises a gaseous neutron moderator, such as H_2, for circulation through a flowpath through the core. Adsorbent material, composed of a metallic hydride, such as ZrH_4, is disposed in the flowpath so that the moderator is retained in the core by sorption on the metallic hydride. The moderator content in the core is varied by varying the sorption conditions. (B.L.M.)

19434 INTERNAL PRESSURIZATION OF A NUCLEAR REACTOR OF THE PRESSURIZED WATER TYPE. McHugh, Brian (to Aktiebolaget Atomenergi). U. S. Patent 3,284,311. Nov. 8, 1966. Filed Dec. 14, 1964.

A simple and reliable means is provided for maintaining an overpressure in a nuclear reactor of the pressurized-water type in which the pressurized water is heated without boiling. A space for water is provided in the lower portion of the reactor tank with the nuclear fuel in the water space. Pressurized water is supplied to the water space to be heated by the nuclear fuel with means being provided for withdrawing the heated pressurized water from the water space. A steam space is provided in the upper portion of the reactor tank with means for producing steam having a temperature higher than the pressurized water and for supplying the steam into the steam space. A thermal barrier is situated below but near the normal operating water level in the reactor for reducing heat transfer from the steam space to the water space. The thermal barrier comprises a partition wall having openings in it for the free passage of water and other openings connected to tubes extending above the normal operating water level in the reactor. The tubes contain partitions dividing them into a number of parallel channels for reducing the circulation of the water in the tubes. At least one of the tubes includes provision for insertion of a control rod for the reactor. (B.L.M.)

19435 FUEL ELEMENT FOR NUCLEAR REACTORS. Hargoe, Bernt Torsten Allan. U. S. Patent 3,281,326. Oct. 25, 1966. Priority date Mar. 9, 1962, Sweden.

A fuel element for a pressurized water reactor in which the moderator and coolant consist of heavy water is of elongated shape and is provided with passages for the flow of the coolant in heat exchange relationship with the fuel. The effective portion for heat exchange extends along about $^9/_{10}$ or preferably along the entire length of the fuel element. A number of cooling passages extend longitudinally of the element, each over only a portion of the length of the fuel, but so that substantially all the fuel is covered by cooling passages. The inlets and outlets to the cooling passages are disposed at several points along the length of the fuel and are all arranged in parallel with regard to the flow of the coolant. The inlets and outlets are adapted for the flow of a portion of the coolant through them longitudinally of the element. (B.L.M.)

19436 NUCLEAR REACTOR. McDaniel, Weymouth N.; Klotz, Charles E. (to Atomic Power Development Associates, Inc.). U. S. Patent 3,285,823. Nov. 15, 1966. Filed Jan. 18, 1965.

A fuel system in which a mobile fuel and/or blanket material is moved at low velocity through the reactor is described with particular application to a fast neutron breeder-type reactor in which the fuel is a paste containing fuel particles at settled density in a liquid medium such as sodium. The fuel and blanket material flow as a paste downwardly through the core and blanket sections of the reactor, respectively, and as low density slurries through separate return lines back to the reactor to form closed circuits. Some or all of the low density slurry may be passed through suitable processing equipment before being returned to the reactor. (B.L.M.)

19437 STANDPIPES FOR NUCLEAR REACTORS. Bromley, Derek (to United Kingdom Atomic Energy Authority). U. S. Patent 3,284,313. Nov. 8, 1966. Priority date Dec. 21, 1962, Great Britain.

Cooling means are described for a standpipe used with a gas-cooled nuclear reactor during refuelling operations. The standpipe extends through the prestressed concrete pressure vessel surrounding the reactor and connects with a channel in the reactor. The prestressing cables of the pressure vessel are disposed in the vessel in such a manner that the longitudinal axes of the cables are disposed at least substantially normal with respect to the longitudinal axis of the standpipe to form a lattice of cables with the standpipe extending through an opening in the lattice. A number of coolant circulation means each comprising at least one pipe having an axis at least substantially parallel with the longitudinal axis of the standpipe through that region of the concrete containing the prestressing cables are provided. The coolant means are located in contact with the outer periphery of the standpipe. (B.L.M.)

19438 BOILING WATER NUCLEAR REACTOR ORGANIZATION. West, John M. (to Combustion Engineering, Inc.). U. S. Patent 3,284,312. Nov. 8, 1966. Filed Oct. 9, 1959.

A boiling water reactor design is described in which both natural and forced circulation of the water is employed in various parts of the core. Forced circulation of the water is provided at the center of the core while natural circulation is provided through the region surrounding the central portion. Dual separation system for the steam and water is also provided. Separation takes place in the reactor vessel, and additional separation is accomplished in the steam and water drum, which forms part of the circulation system. (B.L.M.)

19439 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLY. Thome, Paul (to Commissariat a l'Energie Atomique). U. S.

Patent 3,284,315. Nov. 8, 1966. Priority date Dec. 18, 1963, France.

A fuel element assembly for a gas-cooled reactor consists of canned fuel rods assembled in parallel relation so as to form a fuel cluster. The rods are maintained in the desired geometry by means of at least one support grid having an outer sleeve that is fitted with a heat insulated packing keyed in position to the outer sleeve by means of vibration-absorbing material. The heat insulating packing material is selected from the group consisting of SiO_2, expanded Al_2O_3, SiC foam, and SiO_2 fiber clad with a thin metallic sheet; and graphite felt is used as the vibration-absorbing material. (B.L.M.)

19440 WATER COOLED NUCLEAR REACTOR WITH IMPROVED CORE AND REFLECTOR RECIRCULATION SYSTEM. Williams, Ronald Peter; Hartwell, Roy (to United Kingdom Atomic Energy Authority). U. S. Patent 3,280,004. Oct. 18, 1966. Priority date Feb. 4, 1963, Great Britain.

A nuclear reactor includes a core disposed upright in the reactor vessel for cooling by a water coolant. A baffle surrounds the core and defines with the inner walls of the vessel an annular reflector chamber. A compartment is formed within the reactor vessel above the reflector chamber with a coolant pressurizer disposed within the compartment. An inlet plenum is arranged beneath the lower end of the core, and a number of passages extend upright in the reflector chamber alongside the baffle and are open at their lower ends into the inlet plenum. Coolant conducting means are provided for conducting recirculating coolant from the other end of the core to the upper ends of the passages and include a portion extending outside of the vessel. An inlet duct is connected to the portion outside the vessel and penetrates the vessel adjacent to the compartment. Within the compartment, a divided off flow space connects the duct with the upper ends of the passages. Means are provided for diverting through the compartment and through the reflector chamber a slight flow of recirculating coolant in parallel with the flow through the passages. (B.L.M.)

19441 SINGLE PASS SUPERHEAT REACTOR. Leyse, Carl F. (to Internuclear Co.). U. S. Patent 3,276,965. Oct. 4, 1966. Filed June 17, 1963.

A direct cycle boiling water reactor is provided in which water, preferably light water, is converted to superheated or high quality steam in a single pass through the multi-sectional core. The core region includes fissile atomic material of uniform enrichment distributed throughout the core region. Means are provided for passing fluid through the core region and for simultaneously controlling the fluid feed flow rate and the fluid feed temperature so that the exit temperature of the emitted vapor is regulated and the fluid is converted to superheated vapor of relatively constant exit enthalpy. Separate means are provided for passing fluid through each section of the core region and for passing neutron absorber-containing fluid through each section of the core region by means of which each section can be drained independently of the other to obviate the requirement for mechanically operated control means. The core region also contains a burnable neutron poison material. (B.L.M.)

19442 FUEL ELEMENT FOR NUCLEAR REACTORS WITH PRESSURE TUBES. Alfille, Lucien; Briola, Jean; Dufresne, Jacques; Ohlmer, Eggert (to Communaute Europeenne de l'Energie Atomique-EURATOM). U. S. Patent 3,280,003. Oct. 18, 1966. Priority date Apr. 17, 1962, Italy.

A fuel element design for a heavy water moderated reactor cooled by a fluid flowing under pressure in reactor channels constituted by cold pressure tubes is described. The fuel element is comprised of a cylindrical external housing, a set of parallel bars made of fissile material within the housing, and transverse cross-brace structures secured to the external housing for supporting and spacing the bars. Preferably at the ends of the element, means are provided for axially maintaining and/or containing a thermal insulating sheet wound around the external surface of the jacket. Several fuel elements are secured tightly together in such a way that in making up the load in the pressure tube the sheathings of the elements define a continuous thermal screen adhering to the inner wall of the pressure tube. The jackets define a continuous tube within which the cooling fluid stream is concentrated. (B.L.M.)

19443 NUCLEAR REACTORS. Tollet, Louis H. J.; Maldague, Pierre E. J. M. (to Societe Anglo-Belge Vulcain S. A.). U. S. Patent 3,285,820. Nov. 15, 1966. Filed Aug. 2, 1965.

An assembly for loading and unloading reactors with the support tube for the fuel element including means for cooling and moderating the element is described. The support tube includes means for supporting and centering the tube within the reactor, inlet means at the lower end and outlet means at the upper end for fluid moderator, a drive mechanism at the upper end, and a tubular reactivity control member. The control member is carried by the support tube in concentric relationship with it and is connected to a driving mechanism for actuation by the driving mechanism. (B.L.M.)

19444 BOILING WATER-SUPERHEAT NUCLEAR REACTOR. Straat, Matts Valter (to Aktiebolaget Atomenergi). U. S. Patent 3,284,310. Nov. 8, 1966. Priority date Dec. 4, 1962, Sweden.

A boiling water reactor design includes means for drying and superheating the steam using tubes containing fissile material placed above the water level in the reactor. Two groups of vertical open-ended tubes are arranged within the reactor vessel. The first group of tubes is disposed in the water, and the heating elements within the tubes are positioned substantially in a horizontal plane below the upper ends of the tubes. The water level is well below the upper ends of the tubes. A second group of tubes is arranged within the vessel with their upper ends extending above the water level and communicating with the steam space and with the lower ends extending through the bottom of the vessel. The elements of fissile material are positioned within each of this second group of tubes with the upper ends substantially in a horizontal plane for superheating the steam. A separate heating element is positioned in each of the second group of tubes in the zone between the horizontal plane and the water level for drying the steam passing over each of the superheating elements. Each of the separate heating elements is removable independently of the superheating element. (B.L.M.)

19445 LONG LIFETIME NUCLEAR REACTOR. (to United States Atomic Energy Commission). British Patent 1,062,247. Mar. 22, 1967. Priority date June 26, 1964, United States.

A design is presented for a seed-blanket type reactor which provides for maximization of core lifetime through proper selection of seed thickness and fissile and fertile fuel mass ratios. Tables of seed-thickness, fuel mass ratio, maximum control required, and lifetime are given. Data for both enriched and depleted uranium blankets are given. The design provides an upper limit of peak to average blanket burnup of 2.5/1. (M.L.S.)

Marine and Portable Power Reactors

Refer also to abstracts 18318, 19183, and 19432.

19446 (NUS-278A) NUCLEAR CAPITAL COSTS AND COST TRENDS IN MARITIME APPLICATIONS. Summary Report. Couchman, D. L.; Pletke, L. R.; Woodhall, C. B. (NUS Corp., Washington, D. C.). Oct. 1966. 80p. CFSTI $3.00 cy, $0.65 mn.

Data are presented concerning the direct capital costs, installation costs, schedules, and scope of supply for procurement and testing of three currently offered pressurized water reactors which could be installed as the steam generators for ship propulsion plants with operations commencing in 1970. (J.R.D.)

19447 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR PLANT. (to Babcock and Wilcox Ltd.). British Patent 1,062,395. Mar. 22, 1967. Priority date Feb. 19, 1965, Germany.

A design for a pressurized water reactor for maritime use is given. The reactor has a water shield surrounding it. The containing wall around the water shield and the water shield are separated by a dry annulus which can be filled in event of an emergency. Components around the water shield are situated so that they may be adjusted to form another containing wall if necessary. (M.L.S.)

Rocket and Space Reactors

Refer also to abstracts 18318 and 19183.

19448 (GA-6942) GAMMA AND NEUTRON DOSE MEASUREMENTS FOR A THERMAL TUNGSTEN NUCLEAR ROCKET CRITICAL EXPERIMENT. Houghton, G.; Jupiter, C.; Trimble, G. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). [1966]. Contract SNPC-27. 44p. (NASA-CR-72081).

Radial and axial dose distributions in Core III were measured by inserting thimble ionization chambers in the hollow spine of the fuel elements and poison tubes. The dosimeters were of two types; one sensitive mainly to energy deposition from fast neutrons and one sensitive primarily to gamma radiation. A time history of gamma intensity in the core was recorded. (J.R.D.)

19449 (NASA-CR-72085) SNAP-8 ELECTRICAL GENERATING SYSTEM DEVELOPMENT PROGRAM. Semiannual Progress Report, July 1-December 31, 1965. Report No. 3137.

(Aerojet-General Corp., Azusa, Calif.). Mar. 1966. Contract NAS 5-417. 243p.

The progress development of the SNAP-8 power conversion system and system components during the last half of 1965 is presented. (auth)

19450 (NASA-CR-72103) SNAP-8 ELECTRICAL GENERATING SYSTEM DEVELOPMENT PROGRAM. Semiannual Progress Report, January 1–June 30, 1966. Report No. 3233. (Aerojet-General Corp., Azusa, Calif.). Aug. 1966. Contract NAS 5-417. 285p.

The development progress of the power conversion system (turbine-alternator assembly, pump-motor assemblies, boiler, condenser, and electrical controls) during the first half of 1966 is discussed. (auth)

19451 (SAN-651-16) ORGANIC RANKINE CYCLE TECHNOLOGY PROGRAM. Quarterly Progress Report No. 3, October 1, 1966–January 1, 1967. Internal Report No. AER-468. Adam, A. Warren (Sundstrand Aviation-Rockford, Ill.). Jan. 13, 1967. Contract AT(04-3)-651. 87p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Progress on the development of an organic Rankine cycle power system for use in a space environment is reported. The program areas of investigation included the working fluid (biphenyl and the eutectic mixture of biphenyl and biphenyl ether), bearings, pumping system, and boiler unit. (L.C.L.)

19452 (SC-RR-66-2617) EARTH PENETRATION POST-TEST SOIL EXPLORATION TECHNIQUE. Colp, John L. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 52p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The need for conducting earth penetration tests to obtain information that will aid in a more complete understanding of the earth penetration mechanism is discussed. Methods for investigating the effects of a penetration test upon the surface of the earth target are described. Subsurface soil exploration methods are discussed, and ways to secure, protect, and handle the required soil samples are given. Observations and tests that must be made in the subsurface are described. (auth)

19453 ANALOG COMPUTER STUDY OF THERMIONIC REACTOR POWER PLANT TRANSIENTS. Gronroos, Henrik (California Inst. of Tech., Pasadena). 36p. (CONF-660606-56). DTIE. Gmelin, AED-CONF-66-203-120.

From American Nuclear Society Meeting, Denver.

Simulation of a small low-power thermionic reactor is made so that behavior of such systems in space can be predicted. Plant design of the thermionic space reactor is briefly discussed. Neutron kinetics, thermionic performance, and coolant systems are discussed. Results of the reactor simulation are discussed and conclusions drawn. (M.L.S.)

Process Heat and Desalination Reactors

Refer also to abstracts 18318 and 19183.

19454 NUCLEAR-POWER SEA-WATER CONVERSION PLANT. Lagowski, James P. (to U. S. Atomic Energy Commission). U. S. Patent 3,303,098. Feb. 7, 1967.

A water-cooled nuclear reactor coupled to a flash distillation plant is described. The reactor is located at the bottom of a very deep pit of water. The pressure head of the water above the reactor raises the boiling point of the coolant water substantially above the boiling point of water at atmospheric pressure. The coolant water from the reactor is then flash distilled in a multistage flash evaporator. (AEC)

Research and Test Reactors and Critical Assemblies

Refer also to abstracts 18301 18318, 19183, 19279, and 19432.

19455 (AECL-2636) EXPERIMENTAL INITIAL CONVERSION AND FAST FISSION RATIOS FOR CLUSTERS OF NATURAL U AND UO_2 IN D_2O. de Lange, P. W.; Bigham, C. B.; Green, R. E., Manuel, T. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Sept. 1966. 75p. Dep. mn.

The initial conversion ratio, γ_0, and fast fission ratio, δ, were determined for heavy-water-moderated lattices of 19-rod uranium metal clusters with D_2O or air in the coolant channels and 28-rod UO_2 clusters with D_2O, air, or an organic liquid (HB-40) as coolant. Details of the experimental technique and of the calculation of the results, including corrections, are given. Typically, the cluster-average values of γ_0 are believed to have relative errors of ±0.3% and absolute errors of ±0.85% while the relative and absolute errors on the δ values are ±0.7 and ±1.4%, respectively. Experimental results are compared with lattice calculations. (auth)

19456 (APEX-537) SUMMARY HAZARDS REPORT. NUCLEAR MOCKUP OF P122 FOLDED-FLOW REACTOR RAG-1. Fraembs, D. H.; Hoefer, J. A. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). Jan. 1960. Contracts AF33(600)-38062; AT(11-1)-171. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The RAG-1 (Radial Air Gaps) reactor, a folded-flow, hydrided Zr-moderated, direct-air-cycle reactor and a mockup of the P122 core, is described. Site and testing facilities are described. The safety mechanisms contained in the reactor are discussed, and an accident analysis of the reactor is made. Hazards to the surrounding area due to runaway and fission product release are evaluated. (J.R.D.)

19457 (BNL-50012) ORGANIC-COOLED, HEAVY WATER-MODERATED, ^{233}U FUELED LATTICE EXPERIMENTS. Price, G. A.; Windsor, H. H.; Tunney, W. J.; Hellstrand, E. (Brookhaven National Lab., Upton, N. Y.). Aug. 25, 1966. Contract AT(30-2)-Gen-16. 38p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Material neutron bucklings and thermal flux activation rates were measured for four lattices containing ^{233}U and ThO_2 with D_2O moderation. Accuracy of the buckling measurements is essentially limited by the short fuel length and the small number of clustered fuel elements. The METHUSELAH calculations underestimate the flux depression in the clustered elements by quite a large factor However, the effect on reactivity is relatively small because of compensating absorption in the stainless steel canister. METHUSELAH overestimates the buckling with a corresponding overestimate in k_{eff}. There is a need for improvement in the reactor calculations, although the source of error is not obvious. (auth)

19458 (BNWL-300) ENGINEERING DEVELOPMENT DEPARTMENT QUARTERLY REPORT, JANUARY, FEBRUARY, MARCH 1966. Harty, H.; Batch, J. M.; Pedersen, L. T.; Wheeler, R. G.; Fox, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Apr. 1966. Contract AT-(45-1)-1830. 96p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Developments are reported for studies relating to: civilian power reactors; USAEC-AECL cooperative program; applied and reactor physics; reactor fuels and materials; engineering; plutonium recycle program; nuclear safety; and development of safety rods and oscillator for high temperature lattice test reactor. (P.C.H.)

19459 (BNWL-349) PRTR FUEL ELEMENT QUALITY CONTROL SYSTEM. Keenan, J. P.; Sharp, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan. 1967. Contract AT(45-1)-1830. 21p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Details of quality control and inspection methods used in production of PuO_2–UO_2 fuel elements for PRTR are given. The system presented is a combination of process steps, product control, records, and assignment of responsibilities. (P.G.C.)

19460 (BNWL-CC-904) BURNUP DATA FROM LOW EXPOSURE PLUTONIUM–ALUMINUM FUEL. Christensen, D. E.; Reppond, E. B.; Reardon, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Nov. 1, 1966. Contract AT(45-1)-1830. 128p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A brief description of fuel of the Plutonium Recycle Test Reactor is given along with the data taken. Equations for burnup parameters which can be taken from the data are shown. Curves of atom density versus percent depletion are presented. (M.L.S.)

19461 (GA-7508) SPATIALLY DEPENDENT THERMAL NEUTRON SPECTRA IN SLAB AND ROD GEOMETRIES. Neill, J. M.; Young, J. C. (General Dynamics Corp., San Diego, Calif. General Atomic Div.). Nov. 4, 1966. Contract AT(04-3)-167. 43p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of time-of-flight measurements of thermal neutron spectra in lattices are given. Comparisons between spectral measurements and theoretical predictions for slab and rod geometries are made. An analysis of the assumptions of theoretical calculations of spectral measurements is presented. (M.L.S.)

19462 (HW-80600) HAZARDS SUMMARY REPORT: HANFORD TEST REACTOR (305 PILE). Nilson, R. (ed.) (General Electric Co., Richland, Wash. Hanford Atomic Products Operation). Apr. 1, 1964. Contract AT(45-1)-1350. 111p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A review of the nuclear safety and an assessment of the hazards

associated with the operation of the reactor is presented. The reactor is very safe, and for an error to develop into a potentially serious event, several other independent events or errors must also occur; also, the ability to rapidly insert large positive amounts of reactivity into the reactor does not exist. Finally, there is good ability (both by the reactor itself through the power-limiting, negative Doppler coefficient or by the action of multiple shutdown devices) to terminate possible power excursions well before they can proceed to a serious event. Credible accidents, associated with either loading errors or incorrect usage of control and safety rods, are identified and are subjected to accident analysis through their logical outcomes. For the accidents identified (including the maximum credible accident), the analyses show that there would be no release of fission products. (J.R.D.)

19463 (IAEA-3498-16) PROGRESS REPORT OF NORA PROJECT, OCTOBER 1-DECEMBER 31, 1966. (Institutt for Atomenergi, Kjeller (Norway)). Jan. 1967. Contract AT-(30-1)-3498. 20p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Reactor operation time during the quarter was used for low-power noise experiments, experiments using the neutron generator, and measurements in connection with the experimental work on grey and black neutron absorbers in NORA UO_2-H_2O lattices. Pulsed neutron research is also reported along with research on cell parameters. (J.R.D.)

19464 (IDO-17207) SPERT PROJECT QUARTERLY TECHNICAL REPORT, APRIL-JUNE 1966. Taxelius, T. G.; Potenza, R. M. (eds.) (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Jan. 1967. Contract AT(10-1)-205. 62p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Completion of the Spert-III E-Core static experiments including reactivity worth measurements and temperature coefficients of reactivity is reported. Capsule driver core tests were continued with the performance of 36 short-period transient tests in the period range from 6 to 4 msec. Most of these tests were conducted to determine if the neutron source data are reproducible. In Power Burst Facility (PBF) proof testing, single fuel rods were subjected to high operating temperatures. Other tests were conducted to determine the effects of fuel rod rupture on neighboring fuel rods. Titanium hydride mechanical stability tests were also conducted in the PBF. (J.R.D.)

19465 (IDO-17224) MODEL FOR ANALYSIS OF FAST TRANSIENT REACTIVITY EFFECTS IN LOW-ENRICHED OXIDE-FUELED REACTORS. Houghtaling, J. E. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.). Dec. 1966. Contract AT(10-1)-205. 62p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Thesis. Submitted to Idaho Univ., Moscow.

A reactivity feedback model applicable to short-period power excursions in low-enriched oxide fueled reactors, and the application of this model to such a reactor recently tested in the Spert I facility are described. Performed in a manner consistent with current nuclear design practice, this application resulted in agreement between calculation and experiment within the estimated probable error of about 20% in the calculated reactivity compensation, exclusive of uncertainties in the resonance integral temperature coefficient, γ. While calculations gave best agreement with experiment for a value of γ intermediate between the theoretical value (obtained for the Spert I Core with digital nuclear codes) and available empirical values, agreement in terms of the theoretical value or of published empirical data is not excluded. These results suggest that the reactivity model may be applied to obtain reasonable estimates of reactor kinetic behavior applicable to accident analyses for a large and growing class of thermal reactors using low-enriched oxide fuel. (auth)

19466 (INR-748/IXA/PR) DETERMINATION OF ρ^{28} PARAMETER IN ANNA REACTOR LATTICES. Jozefowicz, E. T. (Institute of Nuclear Research, Warsaw (Poland)). Aug. 1966. 26p. Dep.

Measurements of the ratio of epicadmium to subcadmium neutron absorption rate in ^{238}U (ρ^{28}) were performed in four ANNA zero power reactor using water-graphite-moderated lattices with 14.0 and 19.8 cm pitches and graphite-moderated lattices with 14.0 and 19.8 cm pitches. The method used involves irradiation of fuel pellets enriched UO_2 + Al together with Dy foils in a hole drilled in the multitube fuel element, and the irradiation of the same detectors in the thermal spectrum. Np is separated from the irradiated pellets by reversed phase partition chromatography using TTA as complexing and extracting agent, and ^{239}Np gamma activity is determined as the measure of absorption rate in ^{239}U The results for ρ^{28} are given separately for each fuel tube; the η_f change from about 1.3 to 5.8; the latter for highly undermoderated lattice 14.0 cm pitch without water. (auth)

19467 (KFK-467) DESIGN CRITERIA AND PRELIMINARY CALCULATIONS OF SEFOR SECOND AND THIRD CORES. Caldarola, L.; Tavosanis, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). July 1966. 70p. Dep. mn.

The design criteria for the SEFOR second and third cores were analyzed Scope of the SEFOR second core is the measurement of the Doppler coefficient at high fuel temperatures with a Pu enrichment similar to that of a power reactor and with a neutron spectrum harder than that of the SEFOR first core. Scope of the possibly envisaged SEFOR third core is to test fuel elements and fuel assemblies at the same design conditions as those chosen for the 1000 MW Na-cooled reference reactor. The SEFOR third core would consist of a test zone and a driver zone. In the test zone fuel elements and the fuel assemblies would be tested. The functions of the driver zone are to make the whole reactor critical and the Doppler Coefficient negative and big. The different core design types for the SEFOR third core include a type in which the fuel rods of the SEFOR second core were used in the driver zone and a type in which the fuel rods of the driver zone are different from those of the SEFOR second core and are designed and built only with the purpose to fill the driver zone. The designs of both SEFOR second and third cores are speculative. (auth)

19468 (KFK-472) INITIAL EXPERIMENTS IN THE KARLSRUHE FAST CRITICAL FACILITY, SNEAK. Engelmann, P.; Boehme, R.; Bruhn, G.; Durand-Smet, R.; Foell, W. K.; Habermann, F. W. A.; Schroeder, R.; Wintzer, D. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Oct. 1966. 52p. Dep. mn.

Discussions and data are presented concerning the simulation of fast power reactors, preparations for Na void experiments, and a proposed mockup for simulating the fission products in the SNEAK facility. (J.R.D.)

19469 (KFK-473) INTERPRETATION OF DOPPLER COEFFICIENT MEASUREMENTS IN FAST CRITICAL ASSEMBLIES. Fischer, E. A. (Kernforschungszentrum, Karlsruhe (West Germany). Institut Angewandte Reaktorphysik). Oct. 1966. 22p. Dep. mn.

Analytical results are presented on Doppler experiments in which the reactivity change due to heating samples in fast critical assemblies are measured. A formalism is developed which allows calculation of reactivity changes due to sample heating. (J.R.D.)

19470 (LA-DC-8335) THE LOS ALAMOS THERMAL NEUTRON CAPTURE FACILITY. Jurney, E. T.; Motz, H. T. (Los Alamos Scientific Lab., N. Mex.). Nov. 2, 1966. Contract W-7405-eng-36. 14p. (CONF-661113-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From Slow-Neutron Capture Gamma-Ray Conference, Argonne, Ill.

The internal-target neutron-capture gamma ray facility at the Los Alamos Scientific Laboratory is described. In this facility the target irradiation position is located inside the graphite thermal column of the Omega West reactor. The reactor operating power level is 6.5 MW, which gives a thermal neutron flux of $\sim 2 \times 10^{11}$ n/sec-cm^2 at the target position with a Cd ratio of $\sim 5 \times 10^3$. Targets are placed inside a 9-cm square cross-section bismuth channel having a 3.8-cm-diameter bore along its axis, which traverses the reactor thermal column. One end of the channel is embedded in the reactor shielding, and the gamma radiation from the target is extracted from the other end through collimators. (S.F.L.)

19471 (NP-16450) ASPECTS FINANCIERS DE LA CONSOMMATION D'URANIUM^{235} DANS LES PILES PISCINE DU CENTRE D'ETUDES NUCLEAIRES DE GRENOBLE. (Economic Aspects of ^{235}U Consumption in the Swimming-Pool Reactors of CEN, Grenoble). Merchie, F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar. 2, 1965. 15p. (In French). Dep. mn.

The different factors comprising the fuel budget of the swimming pool reactors of the CEN at Grenoble are examined. The different budget items are represented by curves of the cost as a function of the integrated power and burnup. The importance of the increase of the burnup as a factor of the decrease of cost was deduced. (tr-auth)

19472 (RT-ING-(66)17) SISTEMI DI CONTROLLO DEL REATTORE RTM E DELL'ESPERIMENTO CRITICO RITMO. (Control System for the RTM Reactor and the RITMO Critical Experiment). Roselli, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 1966. 29p. (In Italian). Dep. mn.

R.T.M. reactor and R.I.T.M.O. critical experiment control systems, which include nuclear, process, and radiation monitoring instrumentation, are described. The control system functions

(safety, automatic control, monitoring) are investigated. A detailed accident analysis has been made as a check of control system safety characteristics and to evaluate the reactor self-shutdown ability in the event of control system failure. (auth)

19473 (STI-DOC-10/67) REACTOR PHYSICS STUDIES OF H_2O/D_2O-MODERATED UO_2 CORES: A NORA PROJECT REPORT. Technical Reports Series No. 67. A Summary Report, 1961–1964. Anderson, E.; Berg, J. O.; Doederlein, J. M. (comps. and eds.) (International Atomic Energy Agency, Vienna (Austria)). Oct. 1966. 85p. IAEA: $2.00; Austrian Schillings 52,-; 14/2 stg; F Fr 9.80; DM 8,-.

A summary and review are presented of articles published on the work performed during the project. A list of publications and reports is given in an appendix. The experimental program is described with a report on the reactor statics of systems moderated with D_2O/H_2O mixtures. The development of theoretical models and computer codes used was given. (J.C.W.)

19474 (STI-DOC-10/68) NEUTRON THERMALIZATION IN REACTOR LATTICE CELLS: AN NPY-PROJECT REPORT. Technical Reports Series No. 68. Stamm'ler, R. J. J.; Takac, S. M.; Weiss, Z. J. (International Atomic Energy Agency, Vienna (Austria)). Oct. 1966. 140p. IAEA: $3.00; Austrian Schillings 78,-; £ 1.1.2; F Fr 13,70; DM 12,-.

The results of a joint research program in reactor physics between Norway–Poland–Yugoslavia (NPY) and the International Atomic Energy Agency are given. A theoretical and experimental investigation into the phepomena of neutron thermalization in lattice cells is made. The different lattices of the zero-power assemblies in the NPY countries are undisturbed square lattices with U metal or uranium oxide as fuel. The different energy transfer models and transport theory methods presently used in the NPY countries are reviewed. The computer programs and analytical methods used in the interpretation of the lattice experiments are included. The many variations of activation anrlysis that have been used in the lattice studies are described with emphasis on the different ways in which the perturbing effects have been eliminated or evaluated. The influence of the transport correction and the use of different energy transfer models on the neutron density distribution as well as on the spectrum's spatial variation, expressed in terms of a suitably defined spectrum index, is investigated. (J.C.W.)

19475 (TID–11854) P122C FOLDED-FLOW COLD AIR TESTS ON SINGLE CELL MODEL. Venneman, Walter F. (General Electric Co., Schenectady, N. Y. General Engineering Lab.). Feb. 1, 1961. Contracts AF33(600)-38062; AT(11-1)-171. 74p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For General Electric Co., Aircraft Nuclear Propulsion Dept., Cincinnati, Ohio.

Cold air flow tests were performed on three configurations of 15° sector fuel cartridges with two types of moderator and two types of wire fuel matrices. Pressure loss coefficients and specific weight flow distribution were determined. Flow visualization studies were made and results are included. (auth)

19476 (XDC–59-12-50) FOLDED FLOW REACTOR EXPERIMENTAL PRESSURE LOSSES AND AIR FLOW DISTRIBUTION. Venneman, W. F. (General Electric Co., Cincinnati, Ohio. Aircraft Nuclear Propulsion Dept.). Nov. 25, 1959. Contract AT(11-1)-171. 70p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Cold air flow tests were performed on a 30° sector of a folded flow reactor and duct system containing two opposed wire fuel element banks. Pressure losses were determined for the core alone as well as for the combined core, reflector and annular duct system. Air flow distributions in the fuel elements were determined as a function of radial and axial position. Two basic moderator shapes were investigated. The effect of control blade position on the air flow was found to be minor. The effect of heat addition was simulated by narrowing all exit channels so as to establish the design Mach numbers in them. (auth)

19477 (ORNL-tr-1512) APPLICATION OF THE MODEL CALCULATION "DAGMAR". Wueneke, C. D. Translated for Oak Ridge National Lab., Tenn., from report ABS-THH-1005. 57p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $5.60 fs, $1.91 mf.

Investigations are continued on the application of the model calculation "DAGMAR" to disk-shaped radiation sources before an absorbing half-shape. The influence of the size of the source disk on the flux distribution in the shield and the representation of involutes are studied. Theoretical considerations of the large mock-up experiment for the Siemens MZFR are also presented. (L.B.S.)

19478 AN ANALYSIS OF GRAPHITE MODERATED URANIUM AND PLUTONIUM/URANIUM FUELLED SYSTEMS USING THE LATTICE CODE WIMS. Barclay, F. R.; Wilson, D. J. (Atomic Energy Establishment, Winfrith, Eng.). J. Brit. Nucl. Energy Soc., 6: 80-5(Jan. 1967).

The performance of the reactor lattice code WIMS has been investigated by the analysis of a series of graphite moderated systems containing regular lattices of single rods of uranium or plutonium/uranium metal. Reactivity predictions show a marked dependence on resonance captures in ^{238}U, a reduction of some 12% in these events being required to eliminate this effect. Reactivity comparisons between the Pu/U results and those of corresponding uranium lattices indicate that the best agreement is shown by employing a ^{239}Pu η value of 2.098 ± 0.006, compared with the IAEA (1965) recommended figure of 2.114. Good agreement is shown in the comparison of fission reaction rates, while temperature coefficients and fine structure are reasonably well predicted. (auth)

19479 RECENT FISSILE IRRADIATION CAPSULE DESIGNS. Braunton, C. B. T.; Hobbs, W. R. (Atomic Energy Research Establishment, Harwell, Eng.). Nucl. Energy, No. 1-2, 8-15(Jan.-Feb. 1967).

Selection of the capsule and rig designs for the materials testing reactors Dido and Pluto, and for high power densities in the Dounreay Fast Reactor is described. Details are presented of designs for the measurement of thermal conductivity, center temperature, gas release, swelling of carbide and oxide fuel samples, and fission fragment damage in stainless steels. (INIS–UK)

19480 THE RESEARCH WORK ON THE WATER LOOP IN THE WWR-S REACTOR. Zajic, V. (Inst. of Nuclear Research, Czechoslovak Academy of Sciences, Rez). Kernenergie, 9: 333-45(Nov. 1966).

The equipment and operation of an experimental water loop inserted into the core of the WWR-S research reactor in the Nuclear Research Institute of the Czechoslovak Academy of Sciences is described. The loop facility is used for the investigation of water corrosion on C steels intended for application in construction of the biological shield vessel for a heavy water reactor. The influence of the reactor radiation on the process of corrosion and on the stability of water solutions with corrosion inhibitors is investigated in the loop. Results of research are given and possibilities of water loop exploitation are outlined. (auth)

19481 HEAT TRANSFER AND HYDRAULIC MEASUREMENTS IN A FUEL ASSEMBLY WITH SMOOTH OR ARTIFICIALLY ROUGHENED SIMULATED FUEL ELEMENTS. Grunwald, G. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). Kernenergie, 9: 345-8(Nov. 1966). (In German).

In connection with an increase of the power of the Rossendorf WWR-S reactor from 2 to 4 MW, heat transfer and hydraulic measurements were carried out in a square lattice fuel assembly with smooth or artificially roughened fuel elements. The heat transfer measurements show that with a suitable roughened surface of the fuel elements the heat transfer coefficient can be increased by more than a factor 2 with respect to the smooth fuel element surface. Further measurements were made for studying the heat transfer on the unfavorable cooled fuel elements situated in the corners of the assembly. (auth)

19482 NOISE MEASUREMENTS IN A ZERO POWER REACTOR AND ANALYSIS OF ITS INFLUENCE ON OSCILLATION MEASUREMENTS. Garroni, A.; Lucia, A.; Sciuto, F. (CCR-EURATOM, Ispra, Italy). Energ. Nucl. (Milan), 14: No. 2, 81-94(Feb. 1967).

The results of spectrum analyses of the neutron noise of the AGN 201 reactor at the University of Palermo are given. The noise power spectral density graph is interpreted in terms of transfer functions and the parameters for this are given. The accuracies obtainable in oscillation measurements are considered in the light of various detecting methods. The experimental results obtained fully confirm the theoretical conclusions. (auth)

19483 HIGH-FLUX REACTOR AT THE NATIONAL BUREAU OF STANDARDS. Engineer, 222: 964-6(Dec. 23, 1966).

A description of the 10 MW heavy-water cooled and moderated, enriched uranium reactor of the National Bureau of Standards is given. An outline for proposed use is also given. (TSS)

19484 CORRELATION THEORY OF NEUTRON MULTIPLICATION IN NUCLEAR REACTORS. Kozik, B. (Joint Inst. for Nuclear Research, Dubna, USSR). Kernenergie, 9: 373-7(Dec. 1966). (In German).

A general correlation theory of neutron multiplication in zero-power reactors is discussed on the basis of stochastic point processes. In the case of stationary systems this theory may be reduced to the theory of Green's function of the non-stationary Boltzmann equation. Such a formulation of correlation theory gives an unconstrained connection to the theory of dynamic sys-

tems leading to an exact expression, i.e., to a correct physical interpretation of the driving force of the reactor noise proving to be very lowly dependent on frequency. The theory discussed here represents a basis for treating all space- and energy-dependent problems of reactor noise. In this direction a further concretization is necessary. (auth)

19485 THE PULSED REACTOR OF THE LABORATORY OF NEUTRON PHYSICS IN THE JOINT INSTITUTE OF NUCLEAR RESEARCH. Anan'ev, V. D.; Matora, I. M.; Pogodaev, G. N.; Rudenko, V. T.; Sabalin, E. P.; Sapiro, F. L.; Frank, I. M. (Joint Inst. of Nuclear Research, Dubna, USSR). Kernenergie, 9: 365-73(Dec. 1966). (In German).

Various aspects of the IBR reactor are described including operation in connection with the microtron, power increase to 6 MW, and a comparison of the IBR to other types of pulsed neutron sources. (H.D.R.)

19486 PROPOSED GUIDE FOR THE DESIGN OF A NUCLEAR POOL FACILITY. REVISION 11. Savolainen, Ann W. (ed.). Nucl. Eng. Bull., 4: 8p.(Dec. 1966).

Recommendations for the design of a facility comprising a body of water for attenuating nuclear radiation from a reactor and/or stored radioactive materials are presented. The recommendations apply only to the design of light-water filled pools. Measures developed to cope with health and safety hazards are emphasized. (J.R.D.)

19487 DESIGN AND CONSTRUCTION OF PERISCOPE FOR INSPECTING TRIGA REACTOR FUELS RODS. Dunn, A. L.; Wilger, R. N.; Myers, R. A. (Veterans Administration Hospital, Omaha, Nebr.). Health Phys., 12: 1733-4(Dec. 1966).

Design and construction of a periscope for fuel inspection in the VA Hospital Triga Reactor at Omaha, Neb., are described. The instrument was constructed at a cost of $150.00. (J.R.D.)

19488 DOSIMETRIC INVESTIGATION OF THE ZR-2 AND WWR-S TYPE REACTORS. Makra, Zsigmond. KFKI (Kozp. Fiz. Kut. Int.), Kozlem., 14: 391-400(1966). (In Hungarian).

Measurements using two neutron detectors based on the principle of neutron moderation, an average neutron energy meter, and a long counter are reported. These devices were described in an earlier paper (KFKI Kozlemen., 14: 49(1966)). (auth)

19489 MEASUREMENT OF THE KINETIC PARAMETERS FOR THE RB REACTOR BY MEANS OF THE ROB-1 REACTOR OSCILLATOR. Petrovic, M.; Obradovic, D.; Jevtovic, V. (Boris Kidric Inst., Vinca, Yugoslavia). pp 198-202 of Zbornik Materijala x Jugoslovenske Konferencije o Elektronici, Telekomunikacijama, Automatizaciji i Nuklearnoj Tehnici. Belgrade, Godine, 1966. (In Serbo-Croatian).

The experiments were carried out with the zero-level, heavy-water reactor RB, analyzing the response of the reactor to single-period perturbations by means of the ROB-1 reactor oscillator, which operates as a computing device, multiplying two time-dependent functions and integrating them over a fixed period. The ROB-1 is a dual-purpose machine, multiplying the signals in an analog form and integrating them after conversion to digital form. The response of the reactor was detected by means of an ionizing chamber placed over the core. The measurements were made in the frequency range from 0.07 to 0.7 Hz; at an effect of 2 W, the drop was found to be less than 3%. The transfer functions were determined at grating apertures of 8, 11.3 and 16 cm. (TTT)

19490 OPTIMUM FUEL CHANGE SCHEDULE IN THE RA REACTOR. Strugar, P. (Boris Kidric Inst., Vinca, Yugoslavia). pp 219-23 of Zbornik Materijala x Jugoslovenske Konferencije o Elektronici, Telekomunikacijama, Automatizaciji i Nuklearnoj Tehnici. Belgrade, Godine, 1966. (In Serbo-Croatian).

Fuel changes of the RA reactor are scheduled so that all of the fuel elements are subjected to the same burnup, regardless of their position within the core. This is achieved by a less frequent fuel element replacement at locations with a lower neutron flux. The earlier average burnup of 14.8 MW-days was recently increased by about 20% to 17.8 MW-days. The reactor went critical in 1959 with 56 fuel elements. In January 1962 the burnup amounted to 310 MW-days; at that time additional fuel was introduced, reaching a total of 68 elements and resulting in a burnup by the new core of 357 MW-days. After adding 16 elements, the reactor was operated until a burnup of 579 MW-days was reached. Thus, the overall burnup before replacement amounted to 1246 MW-days. (TTT)

19491 PULSED OR MODULATED NUCLEAR REACTORS. (to Siemens-Schuckertwerke Aktiengellschaft). British Patent 1,057,777. Apr. 24, 1964. Priority date Apr. 24, 1963, Germany.

A design for pulsed or modulated reactors is presented. This consists of a control mass situated outside the reactor core. The reactor is provided with a window to allow passage of neutrons. The control mass can be driven past the window to produce a neutron pulse. Detailed description of the process is given. (M.L.S.)

19492 SWIMMING-POOL REACTOR. Ageron, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,285,824. Nov. 15, 1966. Priority date Mar. 16, 1963, France.

A swimming-pool reactor includes a pool with a horizontal partition wall separating the bottom and top portion of the coolant pool. The reactor core and a number of vertically removable fuel assemblies located in parallel relationship with the core are contained in the bottom portion of the pool. The partition wall consists of a number of individually removable members with each member being associated with at least one of the fuel assemblies so that removal of a member provides passage for one fuel assembly through the partition wall. Withdrawal means are provided for withdrawing a flow of water from the bottom portion of the pool, cooling the greater part of this flow, and returning the greater part of the flow to the bottom of the pool. Connected with the withdrawal means is equipment for directing the remainder of the withdrawn flow from the bottom portion into the top portion so that the water leakages through the partition wall are compensated by the remainder of the flow. (B.L.M.)

19493 PROCESS FOR THE STRATIFICATION OF A BODY OF LIQUID IN TWO SUPERPOSED LAYERS AND INSTALLATION FOR THE APPLICATION OF THE PROCESS. Dollfus, Jacques; Guilloteau, Rene. U. S. Patent 3,284,308. Nov. 8, 1966. Priority date Mar. 26, 1963, France.

A process is described for preventing the mixing of two superposed layers of liquids without the use of a partition, which is particularly applicable to use in the pool of a swimming pool reactor or in the pool for the handling of highly radioactive fuel elements. The process consists of withdrawing water from the bottom contaminated layer, cooling the water, reinjecting it into the bottom layer, withdrawing water from the top and bottom layers, decontaminating the water, bringing the water to a temperature higher than that of the water reinjected into the bottom layer, and reinjecting the decontaminated water into the top layer. The circulation equipment necessary to perform this operation is described in detail. (B.L.M.)

19494 FUEL ELEMENT FOR EXPERIMENTAL NUCLEAR REACTORS. Planquart, Jacques; Herpin, Jacques (to CEN). U. S. Patent 3,280,005. Oct. 18, 1966. Priority date Sept. 6, 1962, Netherlands.

A nuclear fuel element for research reactors consists of a number of fuel plates joined edge to edge by radially-arranged lengthwise braces so as to form coaxial tubes. The braces are provided with extensions beyond the plates. (B.L.M.)

Reactor Components, Fuels and Accessories

Refer also to abstracts 17943, 18203, 18208, 18308, 18310, 18316, 18317, and 18354

19495 (ANL-7261) SECOND-ORDER EFFECTS AS RELATED TO CRITICAL COOLANT-FLOW VELOCITIES AND REACTOR PARALLEL-PLATE FUEL ASSEMBLIES. Wambsganss, M. W. Jr. (Argonne National Lab., Ill.). Nov. 1966. Contract W-31-109-eng-38. 24p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Second-order effects, removed by the linearization process, are retained in a stability analysis of the equation of motion of a flat fuel plate in a reactor parallel-plate fuel assembly. The second-order terms generate an additional stability criterion in the form of an upper bound (critical deflection) on the amplitude of quasistatic deflections for stable oscillations, or neutral stability, about the undeflected fuel plate position. The critical flow velocities are upper bounds to insure local stability about the undeflected plate position. A constant of proportionality relating the critical deflection to the initial channel depth is designated as a design constant. When assigned a value, the design constant defines critical coolant-flow velocities. (auth)

19496 (LA-3607) QUARTERLY STATUS REPORT NO. 1 ON THE ADVANCED PLUTONIUM FUELS PROGRAM FOR PERIOD JULY 1-SEPTEMBER 30, 1966. (Los Alamos Scientific Lab., N. Mex.). Oct. 1966. Contract W-7405-eng-36. 72p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Results of investigations concerned with the interactions of Pu-based fuels with Na, the release and distribution of fission products from irradiated fuel to Na, and methods of altering the fission-product distribution are reported. Data on the solubility of O_2 in Na at 124 to 300°C are tabulated. Activities in a study to define and measure parameters for cold trap design

were devoted to design of a Na test loop. Synthesis and fabrication data and information on PuO_2, Pu carbides, and Pu nitrides are included. Results of phase studies of Pu–C, and U–Pu–C systems using differential thermal analyses are presented. Studies of self-irradiation damage in Pu ceramics reveal that the lattice parameters of normal isotopic composition Pu ceramics increase at a steady rate. A preliminary determination of the crystallographic atomic position for Pu_2C_3 using neutron diffraction was completed. Progress is reported on the use of EMF cells and vaporization studies to determine thermodynamic properties of ceramic fuels. Techniques using high-temperature calorimetry and thermal conductivity are described for determination of the thermodynamic properties of Pu ceramic fuels. Plans for testing the compatability of PuC–UC, and PuN–UN fuels with candidate cladding materials are outlined. Computer programs are being developed for application to reactor kinetics problems, and a burnup program, DTFBUR, to survey life histories of Pu-fueled fast reactors was completed. Progress is reported in development of evaluation methods for neutron cross sections used in reactor calculations. Design work on a high-temperature residual gas analyzer for Na system cover gas is reported. (J.R.D.)

19497 ELECTROSTATIC PARTICLE GUIDE FOR HIGH RESOLUTION CHARGED PARTICLE SPECTROMETRY IN INTENSE REACTOR FLUXES. Oakey, N. S.; Macfarlane, R. D. (McMaster Univ., Hamilton, Ont.). Nucl. Instrum. Methods, 49: 220–8(1967).

A technique was developed to transport tritons, alphas, and fission fragments from high flux regions around a reactor core to distances several meters from the source. The method is being used for high resolution studies of thermal neutron (n,α) reactions and as a means of obtaining intense fluxes of fission fragments. The principle of the technique involves the capture of a charged particle into a spiral orbit in an electrostatic field produced by two charged concentric cylinders. A theoretical study of the trajectory of the particles for various injection angles and radii has been carried out and some of the results are presented. An equation for the collection efficiency has been derived and verified by experiment. Other properties of the system are discussed and some representative particle spectra are shown. (auth)

19498 DISSOLUTION KINETICS OF NUCLEAR FUELS. 2. THORIUM. Kindlimann, L. E. (Allegheny Ludlum Steel Corp., Brackenridge, Pa.); Greene, N. D. Corrosion, 23: 35-8(Feb. 1967).

Electrode kinetic characteristics of thorium in acid and alkali solutions have been measured by potentiostatic and galvanostatic techniques. Application of these data to separation of uranium-thorium alloys is discussed. (auth)

19499 NUCLEAR FUELS. Naumann, Dieter; Burk, Werner; Heyne, Werner (to Deutsche Akademie der Wissenschaften zu Berlin). British Patent 1,062,765. Mar. 22, 1967. Filed May 12, 1965.

A process for the production of spherical uranium-, thorium-, or plutonium-nitride fuel pellets is presented. A design for a reactor core in which the fuel nitride covers a ceramic fuel is also outlined. (M.L.S.)

19500 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain, Societe Anonyme). British Patent 1,059,246. Feb. 15, 1967. Priority date May 12, 1964, Luxemborg.

A process is described for cooling spent fuel when it is desired to change from the reactor coolant fluid to a different type fluid for transporting the spent fuel. This applies, particularly, to heavy-water-moderated reactors. Gas is used as a coolant while the cooling liquid is being changed. (M.L.S.)

19501 CORE STRUCTURES FOR NUCLEAR REACTORS. Oliver, John; Seddon, James Walter (to Nuclear Power Plant Co. Ltd. and A.E.I.–John Thompson Nuclear Energy Co. Ltd.). British Patent 1,054,288. Jan. 11, 1967. Filed Mar. 19, 1964.

A design for a core structure for a gas-cooled, graphite-moderated reactor is given. Reduction of radial column forces due to differential shrinkage of core graphite is accomplished by means of proportionally scaling the block dimensions according to the differential flux across it. (M.L.S.)

19502 NUCLEAR REACTOR FUEL ELEMENTS. Taylor, Alan Frederick; Sheward, George Edward (to United Kingdom Atomic Energy Authority). British Patent 1,062,632. Mar. 22, 1967. Filed Mar. 4, 1963.

A fuel element design is presented in which the end caps of the fuel element are sealed in the ends of the sheath. A blind ended tube which provides a longitudinal hole is located in the fuel material. The open end of the tube is sealed by a secondary end cap, and this, in turn, is sealed inside one end of the fuel element sheath. The hot junction of the thermocouple used for taking internal fuel element temperatures is located inside this blind ended tube. (M.L.S.)

19503 IMPROVEMENTS MADE IN NUCLEAR REACTORS. (to Societe Belge pur l'Industrie Nucleaire "Belgonucleaire"). British Patent 1,055,420. Jan. 18, 1967. Priority date Feb. 11, 1964, Luxemburg.

A design is presented for an in-core reflector for a fast reactor. The reflector is described to be such that neutron absorption and neutron moderation is very small. The advantages of a reflector thus located are that: (1) from a nuclear standpoint, the power distribution in the reactor is flattened, and the requirement of positive temperature coefficient of the coolant fluid is eliminated; (2) from an operations standpoint the control rods are located outside the fuel assembly so that they can remain connected to the drive mechanisms during loading and unloading of fuel. (M.L.S.)

19504 NUCLEAR FUEL ELEMENT. Oldfield, William (to United Kingdom Atomic Energy Authority). British Patent 1,059,831. Feb. 22, 1967. Filed Jan. 3, 1963.

A design for a canned fuel element consisting of two concentric tubular sheaths is given. These sheaths define a fuel area with washers separating the sheaths. The fuel is attached to the inner sheath with a space between it and the outer sheath to allow thermal expansion during irradiation. (M.L.S.)

19505 IMPROVEMENTS IN OR RELATING TO REFUELLING MACHINES FOR GAS COOLED NUCLEAR REACTORS. Packman, Gordon; Kearney, James Leslie (to United Kingdom Atomic Energy Authority). British Patent 1,059,822. Feb. 22, 1967. Filed Apr. 11, 1963.

A design is given for a refuelling machine for gas-cooled reactors. The machine is internally pressurized and is movable across the reactor face with a nose-piece which can be connected directly to any core access tube. The design utilizes the reactor coolant gas as the pressurizing gas. (M.L.S.)

19506 NUCLEAR REACTOR CORE ASSEMBLY. Furgerson, William T. (to U. S. Atomic Energy Commission). U. S. Patent 3,305,449. Feb. 21, 1967.

A core assembly for a nuclear reactor is described in which the elements of the assembly are positioned so that the space between them can be controlled, thereby controlling the flow of coolant between them. (AEC)

19507 FUEL ASSEMBLY. (to Alfa-Laval AB). British Patent 1,057,792. Feb. 8, 1967. Priority date Mar. 4, 1964, Sweden.

A design is presented for a circular fuel element assembly comprised of parallel canned rods which are fastened together at the ends by rod-positioning plates. Coolant channels are provided through the center of the assembly and along the outside of the rods between the rods and wall. Several structural variations of the fuel assembly are given. (M.L.S.)

19508 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. (to Societe Anglo-Belge Vulcain). British Patent 1,054,702. Jan. 11, 1967. Priority date Feb. 7, 1964, Luxemburg.

A design for coolant baffles for liquid-moderated, liquid- or gas-cooled reactors is presented. The baffle is constructed of hexagonally shaped elements welded together at the faces to increase strength. The elements are made of a material which has a low neutron absorption cross-section. (M.L.S.)

19509 IMPROVEMENTS IN BRACES FOR FUEL ELEMENT CLUSTERS. Thome, Paul (to Commissariat a l'Energie Atomique). British Patent 1,057,958. Feb. 8, 1967. Priority date May 22, 1963, France.

A design is presented for a fuel element cluster for liquid-cooled reactors. The cluster is comprised of pencil-type rods arranged around a central tie rod or fuel pencil and separated by spacers which are attached to the rods. Types of materials and methods for fabrication of the braces are given. (M.L.S.)

19510 IMPROVED NUCLEAR REACTOR FUEL ELEMENT HAVING A DIFFUSION BARRIER. Alfille, Lucien; Brossa, Francesc; Theisen, Roger (to European Atomic Energy Community). British Patent 1,057,857. Feb. 8, 1967. Priority date Nov. 16, 1962, Belgium.

A design is presented which provides a diffusion barrier for canned fuel elements of either rod or stacked pellet type. The diffusion barrier is formed by wrapping the entire fuel length of the element with strips or sheets of barrier material. Methods of wrapping, materials used, and methods of securing wrappings are discussed. (M.L.S.)

19511 NUCLEAR FUEL ASSEMBLIES. Webb, John; Ward, Bernard (to United Kingdom Atomic Energy Authority). U. S. Patent 3,281,327. Oct. 25, 1966. Priority date Feb. 13, 1964, Great Britain.

In a nuclear fuel assembly in which a number of elongate fuel elements are arranged with their longitudinal axes paralled, a parallel array of spacer diaphragms is penetrated by the fuel elements and serve to hold the elements in spaced relation with each other. The diaphragms are tilted with respect to the longitudinal axes of the elements and serve to promote swirling of coolant flow as well as to space the elements. Preferably each spacer diaphragm has a series of apertures, each aperture serving for passage of an individual fuel element, and the spacer diaphragms overlie one another to the extent that a fuel element passing through an aperture in one diaphragm makes contact with an end portion of at least one adjacent diaphragm. Preferably the diaphragms are supported within a sleeve, and the space within the sleeve is divided into a number of sectors, each having an array of parallel diaphragms. The orientation of the diaphragms within the sectors is such that a rotational component of flow is imported to the main coolant flowstream. (B.L.M.)

19512 TUBULAR ELEMENT WITH FINS. Maillet, Ennemond (to Commissariat a l'Energie Atomique). U. S. Patent 3,277,960. Oct. 11, 1966. Priority date Jan. 26, 1962, France.

A heat transfer element, such as a heat exchanger wall or a fuel element can, comprises a tubular member having a passage extending through it. The outer surface of the member is of a generally polygonal configuration as viewed in transverse cross section and provides a number of identical sectors arranged around it. The external surface of each of the sectors is cylindrical with the axes of the cylindrical surfaces extending parallel with the axis of the member and is disposed outwardly from the outer surface of the member so that a projection of the external surface of the sectors onto a plane at right angles to the axis of the member defines for each sector a curve having a general concavity that is directed outwardly from the member. A number of fins are formed integral with the member and extend outwardly from the surface of each of the sectors. The fins are parallel to each other on each sector and are inclined at an angle to the axis of the member and in opposite directions in adjacent sectors so as to form a herringbone pattern. The fins on each sector define portions of helicoids and are of constant height over a major portion of their length. (B.L.M.)

19513 IMPROVEMENTS IN OR RELATING TO LEAK DETECTION, PARTICULARLY IN NUCLEAR FUEL ELEMENTS Morgan, Frank (to United Kingdom Atomic Energy Authority). British Patent 1,062,292. Mar. 22, 1967. Filed Feb. 12, 1965.

A method of detection of leakage of fuel element cans is given. The method for distinguishing a failure from regular radiation of the coolant is use of an alpha emitter enclosed inside the fuel can. The coolant is then monitored for alpha contamination. (M.L.S.)

19514 CONTROL ROD FOR A NUCLEAR REACTOR. (to Atomic Energy of Canada Ltd.). British Patent 1,058,657. Feb. 15, 1967. Priority date Sept. 28, 1964, United States.

A design is given for a control rod which is slotted. These slots can be used for irradiating materials to be converted into radioisotopes. (M.L.S.)

19515 IMPROVEMENTS IN OR RELATING TO THE MANUFACTURE OF ELEMENTS FOR NUCLEAR REACTORS FROM METAL STRIPS OR RIBBONS AND THE PRODUCTS OBTAINED THEREBY. Alfille, Lucien; Honnorat, Raymond; Ropers, Jean; Fernandez-Martinez, Roberto (to Commissariat a l'Energie Atomique). British Patent 1,059,075. Feb. 15, 1967. Priority date Mar. 29, 1963, France.

A method of manufacturing fuel elements from metal strips of fissionable material is presented. Pre-treating and fabrication techniques are described for various geometric shapes. (M.L.S.)

GENERAL

19516 (AERE-R-5003) FEASIBILITY OF OPTICAL WRITING AND READING ON MAGNETIC AND OTHER RECORDING MEDIA. Franklin, E. (Atomic Energy Research Establishment, Harwell (England)). Jan. 1967. 28p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. HMSO 5s. 6d.

The feasibility of achieving high information packing density on recording tape by the use of optical write and read methods is discussed. The principal recording medium considered is magnetic metal film, but some attention is given to a number of other possible media. It is concluded that magnetic film appears the most promising at present. (auth)

19517 (BNL-9678) LEAST-SQUARES MONTE CARLO METHODS FOR SOLVING LINEAR SYSTEMS OF EQUATIONS. Halton, John H. (Brookhaven National Lab., Upton, N. Y.). Nov. 1965. Contract AT-30-2-GEN-16. 75p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The application of the Monte Carlo method to the computation of the least (weighted) square approximation to the solution of a system of N linear algebraic equations in n unknowns, with $N \geq n$, when the numbers N and n are hopelessly large, is described. The only limitation is that it should be possible either to store or calculate the coefficients of the system and to make a search among them (or provide adequate estimates by other means). The basic principle used, which is central in many Monte Carlo techniques, is that of replacing sums by suitably sampled values of the summand. This enables us to avoid the lengthy computation of matrix-multiplications. A workable sequential Monte Carlo process is also described, which much accelerates the convergence of the estimates in many cases. When the system is a discretization of a continuous problem (an integro-differential form of equation), further refinements may be applied. In this connection, the concept of weak orthogonality and a Monte Carlo Gram-Schmidt process are introduced, and also the technique of progressive refinement of the grid, in the sequential method. (auth)

19518 (BNWL-346) DERIVATION OF EQUATIONS TO DETERMINE FREQUENCY DISTRIBUTIONS OF PARTICLE SIZE. Sehmel, G. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Oct. 1966. Contract AT(45-1)-1830. 27p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method was developed for obtaining a mathematical expression which represents particle size frequency distributions when the measured distributions are originally specified in terms of size increments. The method is particularly applicable when a measured size distribution does not correspond to the normal, log-normal, and Weibull distributions. Nevertheless, the method is also applicable to these distributions over the limits of the experimental data. The method is an iterative least squares technique to fit a partial distribution function over the size range of the experimental data. Particle size data are represented which were initially grouped into seven size increments, but the method should have applicability to any number of size increments. (auth)

19519 (CEA-R-3118) CONSTANTES DES REACTIONS, EN MILIEU CYCLOHEXANE, DES LAURYLAMINES AVEC L'ACIDE TETRABROMOPHENOLPHTALEINE MAGENTA E. (Reaction Constants, in Cyclohexane, of Laurylamines With Tetrabromophenolphthalein Magenta E Acid). Perez, Jean-Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Nov. 1966. 32p. (In French). Dep. mn.

Tridodecylamine is an extracting agent used for plutonium purification. Its main degradation product is didodecylamine. Titration of this impurity was carried out by spectrocolorimetry in cyclohexane using tetrabromophenolphthalein Magenta E as colored acid indicator. The dissociation constants reported for alkoylammonium salts are to close to lead to a discrimination between secondary and tertiary amines. The spectrophotometric results showed that the ratios of various dissociation constants for tetrabromophenolphthalein Magenta E salts are notably different from those for salts of simple colored acids like 2,4 dinitrophenol. The structural changes accompanying the colorations are discussed in order to explain this phenomenon. (auth)

19520 (EGG-1183-2133) PHOTOGRAPHIC EMULSION TRANSFER STUDY. Number S-369-R. Blethrow, David S. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Mar. 1967. Contracts AT(29-1)-1183; W-7405-eng-48. 12p. (UCRL-13281). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

For Univ. of California, Lawrence Radiation Lab., [Livermore].

A technique for removing an exposed photographic emulsion from a nontransparent backing and transferring it to a transparent backing to make it suitable for transparency-type projection is discussed. The requirements were that the emulsion must not be damaged, undergo dimensional distortion, or suffer loss of image resolution. A successful technique was developed using a commercial laminating machine. Efforts to accelerate the process by using a roll-type laminating machine were unsuccessful because the machine selected for test lacked sufficient operating control. (auth)

19521 (NYO-1480-69) DETACHED SHOCK CALCULATION BY SECOND ORDER FINITE DIFFERENCES. Lapidus, Arnold (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). Feb. 1967. Contract AT(30-1)-1480. 55p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A detached shock problem for a symmetric curved convex cylindrical body moving parallel to its plane of symmetry was solved using a third order accurate Richtmyer form of the Lax-Wendroff conservation equations. One innovation is an easy to use "artificial viscosity" term which preserves the high order of accuracy of the calculation while removing the nonlinear instabilities which otherwise appear in the shock region and near boundaries. Another innovation is a simple transformation of Cartesian space which changes the curved body into a straight line, thus reducing the large number of special points and irregularly shaped mesh regions which would otherwise appear in the difference method calculation. Such transformations are shown to preserve the conservation property of the system of differential equations. Other aspects of the third order artificial viscosity term and the transformation are discussed. The results of a numerical calculation on a CDC 6600 Computer are compared to known results. (auth)

19522 (NYO-1480-70) EIGENFUNCTION EXPANSIONS ASSOCIATED WITH THE LAPLACIAN FOR CERTAIN DOMAINS WITH INFINITE BOUNDARIES. Goldstein, Charles Irwin (New York Univ., N. Y. Courant Inst. of Mathematical Sciences). Feb. 1967. Contract AT(30-1)-1480. 77p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

An expansion theorem for the negative Laplacian $-\Delta$ acting on functions with zero boundary conditions in a perturbed semi-infinite cylinder in N-dimensional Euclidean space ($N \geq 2$) is proven. The case of an unperturbed cylinder is discussed. The spectral multiplicity is completely determined and a complete, orthogonal set of general eigenfunction is explicitly given. The finite end of the cylinder is then subjected to certain perturbations. Two sets of generalized eigenfunctions are constructed for the perturbed cylinder. They are constructed using the method of limiting absorption. The behavior of these eigenfunctions at infinity is described by means of a radiation condition analogous to the Sommerfeld radiation condition for the exterior problem. These functions are shown to form a complete, orthogonal set of generalized eigenfunctions for certain types of perturbed cylinders. Finally, it is shown for a wider class of domains that there can be at most a finite number of linearly independent generalized eigenfunctions associated with each real number. (auth)

19523 (ORO-3443-3) DISCRETIZATION ERROR IN THE CLASSICAL DIRICHLET PROBLEM FOR LAPLACE'S EQUATION BY FINITE DIFFERENCE METHODS. Bramble, J. H.; Hubbard, B. E. (Maryland Univ., College Park. Inst. for Fluid Dynamics and Applied Mathematics). Jan. 1967. Contract AT(40-1)-3443. 57p. (BN-484). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The classical Dirichlet problem for Laplace's equation in a bounded subdomain R of E_n is treated by finite difference methods. Error estimates are obtained which are consistent with other results by proving the following theorem: if ∂R is C^2 and $u \in H(p, A_p, \lambda)$ then $\max |u(\chi) - u(\chi, h)| \leq K(\epsilon)[h^{p+\lambda-\epsilon} + h^2]$, $p = 0, 1, 2 \ldots$ where K depends only on geometric quanties, as well as A_p, λ, and $\epsilon > 0$. The result asserts that if u satisfies a Hölder condition for any exponent $\lambda > 0$, no matter how small, then by choosing $\epsilon < \lambda$ the rate of convergence $h^{\lambda-\epsilon}$ is obtained. Various generalizations of this theorem are given, which include the corresponding result for higher order approximations and, in E_2, the case where ∂R is composed of C^2 arcs with no re-entrant cusps. (L.B.S.)

19524 (SC-RR-66-553) DATA-REDUCTION TECHNIQUE FOR THE ANALYSIS OF NONLINEAR MOTION. Iversen, James D. (Sandia Corp., Albuquerque, N. Mex.). Jan. 1967. Contract AT(29-1)-789. 31p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

A method is proposed for the determination of aerodynamic stability derivatives of flight vehicles from experimental free-

flight or wind tunnel nonlinear motion data. Results of the method are compared with experimental data for one- and two-degree-of-freedom motion. (auth)

19525 (SC-TM-66-613) USE OF THE KOLMOGOROV–SMIRNOV STATISTIC TO VALIDATE SUPPLIERS' INSPECTION RESULTS. Berger, Roger W. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 23p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

The application of nonparametric techniques to the problem of validating suppliers' variables-type inspection results is summarized. Because of its desirable mathematical properties, ease of application, and freedom from restrictive assumptions, the Kolmogorov–Smirnov statistic is used. By exact and approximate equations, tables of significance probabilities are extended and placed in different order for ease of application. Properties of the test and techniques for calculating probabilities are discussed. (auth)

19526 (SC-TM-67-48) SHOCK ABSORBING SYSTEM FOR INSTRUMENT STATIONS LOCATED IN STRONG EARTH MOTION FIELDS. Holmes, H. (Sandia Corp., Albuquerque, N. Mex.). Feb. 1967. Contract AT(29-1)-789. 15p. Dep. mn. CFSTI $3.00 cy, $0.65 mn.

Instrument stations containing shock sensitive electronic equipment must frequently be placed at locations where earth motion from an underground blast is greater than motion the usual shock absorbing system will satisfactorily protect against. A shock absorbing system, utilizing crushable honeycomb that may be used alone or in conjunction with other shock absorbing systems, is described. (auth)

19527 (UCRL-50001-66-1) PHYSICS DEPARTMENT REPORT, FEBRUARY 1966–May 1966. (Lawrence Radiation Lab., Univ. of California, Livermore). Contract W-7405-eng-48. 80p. Dept. mn. CFSTI $3.00 cy, $0.75 mn.

Separate abstracts were prepared for the 4 included sections. (M.O.W.)

For abstracts of individual sections see: 18367, 18411, 18752, and 19296.

19528 (Y-DA-1587) INDUSTRIAL LASER POSITIONING APPLICATIONS. Schede, R. W. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Mar. 6, 1967. Contract W-7405-eng-26. 22p. (CONF-670404-1). Dep. mn. CFSTI $3.00 cy, $0.65 mn.

From American Ordnance Association, Standards and Metrology Division Meeting, Gaithersburg, Md.

The basic characteristics, operational characteristics, accuracy, machine mounting, and performance of the laser interferometer are discussed. (B.G.D.)

19529 (UCRL-Trans-10094) ON THE FIXED DIRECTIONS OF THE PRODUCT OF SOME OPERATORS. Vainberg, M. M. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from Dokl. Akad. Nauk SSSR, 85: 261-3(1952). 10p. Dep. mn. CFSTI $3.00 cy, $0.65 mn. JCL $1.10 fs, $0.80 mf.

19530 AEC, INDUSTRY, UTILITIES EXPLORE PRIVATE ENRICHMENT POSSIBILITIES. Jeffery, Grant. Nucleonics, 25: No. 2, 54-7; 84(Feb. 1967).

Views of the AEC, private industry, and public utilities on the possibility of private uranium enrichment are discussed. Some questions considered are: the urgency of private participation in enrichment; availability of classified information; prospects for methods of enrichment other than gaseous diffusion; would a monopoly be created which would damage competition; and would private enrichment bring cheaper fuel costs and if so would savings be passed on to public utilities. A short history of uranium enrichment in the U. S. is given. Other methods of enrichment such as thermal diffusion, electromagnetic, gas centrifuging, and chemical separation are summarized. (F.S.)

19531 NUCLEAR RESEARCH AND TECHNIQUES IN THE GERMAN FEDERAL REPUBLIC. Rembser, Josef (Ministere Federal de la Recherche Scientifique, Godesberg, Ger.). Bull. Inform. Ass. Belge Develop. Pac. Energ. At., 11: No. 64, 9-22; 27(Nov. 1966). (In French).

An outline is given of the nuclear research and development undertaken in the German Federal Republic by the state, universities and independent institutes, and industry. The contribution of the Republic to EURATOM and CERN is first outlined. Nuclear research in the German universities and Max Planck institutes, German nuclear research establishments, and industrial development of nuclear techniques are then summarized. (J.S.R.)

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